ON SPACE WARFARE

A Space Power Doctrine

by

David E. Lupton, Lt Col, USAF, Retired
Airpower Research Institute

Air University Press
Maxwell Air Force Base, Alabama 36112-5532

June 1998

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **JUN 1998**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**

4. TITLE AND SUBTITLE **On Space Warfare: A Space Power Doctrine**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) **David E. Lupton**	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air Univ, Maxwell AFB, AL**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS
Space warfare; Astronautics, Military - United States; United States - Military policy

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**SAR**	**94**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Library of Congress Cataloging-in-Publication Data

Lupton, David E.
On Space Warfare: A Space Power Doctrine by David E. Lupton.

Bibliography:
1. Space warfare. 2. Astronautics, Military--United States. 3. United States--Military policy.
1. Title.
UG1530.L86 1988
358.8--dc 19 88--19765
CIP

DISCLAIMER

This publication has been reviewed by security and policy review authorities and is cleared for public release.

For Sale by the Superintendent of Documents
US Government Printing Office
Washington DC 20402

In Memory of Emerson R. Lupton, Claude A. Lupton, and William Broadhurst

CONTENTS

Page

FOREWORD

Ever since President Ronald Reagan's speech on ballistic missile defense (BMD) in March 1983, the military use of space has become a hotly debated topic. President Reagan did not mention space, only a plan to place renewed emphasis on the development of a BMD technology. Nevertheless, the speech was promptly dubbed Star Wars because the space environment seems to be the most likely place to deploy a ballistic missile defense system, and several administration officials mentioned space-based BMD systems as technological possibilities.

Although Americans are accustomed to public debate concerning the merits of proposed weapon systems, the Star Wars controversy covers issues much broader. Will space-based weapon systems allow a new strategy to replace assured destruction which (under several different guises) has been a cornerstone of US defense since the dawn of the nuclear age? Are we prepared to militarize space, an environment that has been treated as a war-free sanctuary since the Eisenhower administration? The intensity behind the space militarization issue can be seen in the current congressional debate about testing of US antisatellite weapons. Are space-based weapons that have been proposed for BMD purposes technologically feasible?

In military jargon, the Star Wars debate is military doctrine or beliefs about the best way to conduct military affairs. Doctrines are difficult to analyze, even quantitatively. The bases for belief structures are often ill-defined, exist at a subconscious level, and are difficult to articulate and analyze. Moreover, belief structures are not often subjects for unemotional debates. Doctrines also give rise to practices that become traditions and survive longer than the bases for the belief structures that supported them. These traditions often become the bases for justifying the doctrines rather than the doctrines justifying the traditional practices. For these reasons, books on military doctrines are often short on analysis and long on justification of a particular doctrine.

On Space Warfare: A Space Power Doctrine provides exceptional insights into the various doctrines that do or would govern military affairs in the space environment. Its strengths are the author's ability to articulate the various doctrines, the historical perspective from which these doctrines are examined, and the broad context from which these doctrines are viewed.

This book is extremely topical and provides exceptional vantage into the current issues regarding space. 'The author has clearly defined the various belief structures or doctrines on both sides of the Star Wars debate. The articulation of these various doctrines is of tremendous value to those who wish to understand not only the opposition's beliefs but also the roots of their own beliefs.

The value of this book goes far beyond the edification of current issues. The author has laid the groundwork for a space power doctrine that may have an impact similar to Mahan's sea power doctrine and the pioneering air power doctrine described in Field Manual 100-20, Command and Employment of Air Power.

SIDNEY J WISE
Colonel, USAF
Commander
Center for Aerospace Doctrine, Research, and Education

ABOUT THE AUTHOR

After graduation from Pennsylvania State University in 1963, David E. Lupton entered the Air Force through Officer's Training School. His first assignment was as an instructor at the missile school at Sheppard AFB, Texas, where he taught rocket fundamentals. In 1965, he was reassigned to the Space Training Branch where he taught orbital mechanics to many of those involved in early Air Force space programs. In 1965, Lupton and other members of the Space Training Unit were assigned to Keesler AFB, Mississippi, where they set up the initial training courses for the orbital analyst career field.

In 1969, Lupton was transferred to the Headquarters Strategic Air Command, Directorate of Plans, where he performed staff duties involving warning and surveillance systems. After an AFIT tour at the University of Missouri, where he received his master's degree in mathematics, Lupton spent five years in various assignments at the National Security Agency.

In 1977, he was transferred to the USAF Airlift Center, Pope AFB, North Carolina. As director of the Operations Support Division at the Airlift Center, he provided technical support to the Military Airlift Command operational test and evaluation programs.

From 1980 to 1983, Colonel Lupton was one of the initial research fellows in the newly created Airpower Research Institute. This book was written during that assignment. Upon his retirement from the Air Force, he joined the staff of the Geodynamics Corporation in Colorado Springs, Colorado, as the strategic programs manager.

PREFACE

In his history of Air Force thought from 1907 to 1964, Dr Robert F. Futrell documented the Air Force's long-standing difficulty in articulating an air power doctrine or even agreeing on a definition of doctrine. When the research for this book was started in 1980, these same shortfalls were still apparent in the published air and space doctrines. Air Force doctrine manuals contained six different definitions of doctrine. Furthermore, the contents of the manuals had little relationship to the definitions and were primarily lists of Air Force missions and functions. Not only was the published air power doctrine deficient, but this inadequate air power doctrine was extended to the space environment through the use of the word *aerospace*.

Chapter 1 was necessitated by this doctrinal climate. Chapter 1 describes my concept of doctrine, which is derived from the writings of Professor I. B. Holley and Lt Col Dennis M. Drew. Although the scientist in me would like doctrine to be based on well-proven principles and carry the weight of rules, I can find no evidence of such principles or rules in existing air, sea, or land doctrines. The employment of military forces is an art, rather than a science supported by controlled, reproducible experiments. Therefore, the practitioners of military affairs must derive their doctrines from very limited military experience and unproven postulates. Beliefs, rather than rules or principles, describe the nature of doctrine. I believe that Professor Holley's definition ("Military doctrine is what is officially believed and taught about the best way to conduct military affairs") best describes what doctrine should be.

The space force characteristics described in chapter 2 were initially developed in reaction to the published aerospace doctrine but were found to have a greater value once they were defined. These characteristics are words and phrases that summarize the military experience supporting doctrine. I view the characteristics described in chapter 2 as tentative attributes that must be reexamined and refined based on new experience with space forces.

Although I agree with Professor Holley that doctrines should be officially published and taught, I found early in my research that the primary doctrines governing space forces were neither published nor taught. In fact, the official aerospace doctrine was less of an influence on military space affairs than was the sanctuary doctrine, the belief that space should be a war-free sanctuary. The sanctuary doctrine and three other unofficial doctrines are described in chapter 3.

Chapters 4 through 7 analyze these unofficial doctrines. This examination is based on the characteristics described in chapter 1 and the military experience that can be extrapolated from air, sea, and land power doctrines. The results of the first three doctrines lay the groundwork for the preferred doctrine (the space control doctrine) described in chapter 7.

Chapter 8 describes the five pillars necessary to support a space power doctrine. The first of these pillars is a space logistics structure that provides us better access to the environment than our possible adversaries have. The second pillar is the ability to use man's talents and capabilities in space. The third pillar is a space-based space reconnaissance and surveillance system to monitor events in space. The development of space control weapons is the fourth pillar, and the last pillar is the formation of the proper organizational arrangements to employ our space forces.

The majority of my work on this book was completed by September 1983. Some additional sources were added in 1984 as the manuscript was going through the editorial process. During the period when the manuscript was undergoing Air Force security and policy review, no substantive revisions or updates were possible without triggering another iteration of security and policy review. Therefore, the formation of USSPACECOM, the shuttle disaster, and the Strategic Defense Initiative are not included in the discussions. In addition, the final manuscript was edited in response to security and policy review. Notwithstanding these shortfalls, I believe the basic tenets of this book are sound and that recent events tend to support rather than detract from my arguments.

The weaknesses of this book are my own while the strengths reflect efforts of the many who helped. Col Thomas Fabyanic (USAF, Retired), the founder and first director of the Airpower Research Institute (ARI), provided the environment which nurtured this book. The second director of the ARI, Col Kenneth J. Alnwick, was encouraging and patient even when the going was slow. Lt Col Dennis Drew not only provided a basis for my view of doctrine but showed by example that lieutenant colonels could make contributions to military thought. Dr Robert F. Futrell's pioneering work on Air Force doctrine was invaluable. Dr Donald Mrozek provided much-needed advice and taught me the motto (inch-by-inch everything is a cinch) that kept me going. The ARI and Air University Press editors (John Schenk, Hugh Richardson, Tom Mackin, Dorothy McCluskie, and Pat Smithson) performed outstanding work in turning my work into a readable book. Jo Ann Perdue, Edna Davis, Marcia Williams, Connie Smith, and Annie Dinkins not only did exceptional work on the manuscript but speeded up my work by teaching me how to use the word processor. Nancy, Allison, Chip, Bill, and Donna provided the critical support on the home front that was so essential to this effort.

DAVID E. LUPTON
Lieutenant Colonel, USAF, Retired
Airpower Research Institute

CHAPTER 1

SPACE POWER, SPACE FORCES, AND DOCTRINE

Phrases such as *space power* and *space forces* cause an intense, unfavorable reaction in the United States.(1) The average American citizen views space as the responsibility of the National Aeronautics and Space Administration (NASA) and its peaceful exploration programs, such as the one that put men on the moon. Because even then on aggressive military space activities have been hidden behind a veil of secrecy, the citizenry is largely unaware that the military has any role in space.(2) Therefore, any military space activities, particularly those done under the guise of “space power” by “space forces,” are seen as examples of military efforts to invade a peaceful sanctuary.(3) After all, this nation has been peacefully exploring the fourth environment for more than 25 years without military involvement, so why should the military make a muck of it now?

A similar wish to avoid military activities in space is also apparent among many military officers. The complexity of the military profession, brought on by rapidly changing technology and a multipolar world, reinforces a desire not to add to this complexity by opening a new environment to military activities. The continual demands to provide more defense with shrinking budget dollars have also weighed against new forces of largely unproven military utility being stationed in a distant environment**.** Therefore, for a multitude of reasons, many Americans want the original policy governing US space activities to continue. As stated in the National Aeronautics and Space Act, is policy “that activities in space should be devoted to peaceful purposes for the benefit of all mankind.”(4)

The purpose of this book is to explore the requirements set forth by the next paragraph in the same act.

The general welfare and *security* of the United States require that adequate provision be made for aeronautical and space activities.... Activities peculiar to or primarily associated with the development of weapon systems, military operations, or the defense of the United States...shall be the responsibility of, and shall be directed by, the Department of Defense (emphasis is added).(5)

In other words, the purpose of this book is to determine whether space power should have the same military connotation as air power and sea power, and if there should be such things as space forces.

Before starting this endeavor, this chapter defines several important terms and explores a concept that is critical to the analysis that follows. The critical concept is doctrine, a concept common to the military and clergy. This chapter is in part designed for readers who belong to neither of these professions. Moreover, even though doctrine is touted as a mystical remedy for all problems, there seems to be no common definition even among those few military professionals who claim to understand it.(6) Therefore, the main purpose of this chapter is to present my concept of doctrine, in an attempt not to make converts but to provide a framework for what

follows. While explaining my view of doctrine, the chapter defines the phrases *space power* and *space forces* and briefly explores the relationship between doctrine and strategy.

One reason for confusion about doctrine is that it is often defined using four very different operative words--*principles*, *rules*, *beliefs*, and *ideas*.(7) For example, doctrine is a set of principles (or rules) that govern the employment of forces. Or doctrine is the basic beliefs (ideas) that represent the best way to employ military forces. Using Webster's definition of these words, doctrine seems to be somewhere between fundamental law (principle) and a partially formed concept (idea). Adding to this confusion is the fact that advocates of a given doctrine believe their doctrine assuredly consists of principles and those who disagree are only proposing partially formed concepts (half-baked ideas).

Doctrine can be best described as a set of beliefs. If there are fundamental laws or even rules for employing military forces, then why is it that almost every nation and even the separate services of a single nation have different sets of principles?(8) Furthermore, some commanders win battles by applying certain principles while others are defeated while applying the same principles. If there are prescriptive principles of war, why is warfare an art rather than a science? At the other extreme, if doctrine is defined as a set of ideas, then are anybody's ideas doctrine? Are there good and bad doctrines just as there are good and bad ideas? Most doctrinal thinkers avoid these questions by defining doctrine as ideas that are tested through experience or logical inference until they become official beliefs.(9)

Professor I. B. Holley has suggested a definition that places doctrine in this ideal state of "tested" beliefs: "Military doctrine is what is officially believed and taught about the best way to conduct military affairs."(10) This definition represents the ideal state; that is, what doctrine should be but almost never is because beliefs that govern the conduct of military affairs are not always taught nor officially pronounced. For example, although Adm Alfred Thayer Mahan taught his sea power doctrine at the Naval War College and numerous highly placed government officials were disciples (e.g., then Assistant Secretary of the Navy Theodore Roosevelt), it was not published as official US Navy doctrine nor did all of the Navy high command consider it of great value.(11) Similarly, the air power doctrine taught at the Air Corps Tactical School during the 1930s and which guided the employment of air forces in early World War II was not officially published until 1943.(12) More important to the thesis of this book, military systems were used in the space environment for almost 25 years before a space doctrine was published.(13) During this time, the Air Force's basic doctrine manual was modified to include space by the invention of the bastardized word *aerospace*, but whether the manual described any of the beliefs that governed the employment of space forces is highly debatable.(14) In addition, not until the early 1980s was space doctrine included in the curriculum of the Air War College.(15)

Although I agree with Professor Holley that doctrine should be official beliefs that are taught, I must be realistic and note that doctrine is also those unofficial beliefs that have a major influence on the conduct of military affairs. Two of the four belief structures or doctrines detailed in chapter 3 have directed military affairs in space for many years. The other two have had some past influence and will have enormous future impact if their disciples attain positions of power in the Department of Defense (DOD). Labeling these beliefs as merely ideas would understate the

influence they do or could exert on the conduct of military affairs. Therefore, I will identify these belief structures as doctrines in the hope that they will be recognized as having the influence of doctrine, and that the best one will be published as official doctrine and taught to those military leaders who will plan and conduct our military affairs in space.

One reason doctrine should be published and taught is that it is one of the foundations on which strategies are based. Therefore, it is useful to explore briefly the relationship between strategy and doctrine. Simply put, a strategy is a plan used to marshal and direct resources to achieve some objective. Several levels of strategy can be distinguished. A grand or national strategy applies all elements of power (political, military, economic, etc.) to achieve some national objective (e.g., national survival). A military strategy is a plan that organizes and directs the military element of national power to achieve a military objective that is, or should be, a part of a national objective. Finally, at the lowest level are battlefield strategies, commonly called tactics, which are usually pro forma plans to achieve recurring objectives. An example of such low-level strategies is the more or less standard air tactics used in dogfights that have the objective of destroying enemy aircraft.

Strategies that employ military forces to achieve objectives are naturally based on beliefs or doctrines about the best way to employ forces. Beliefs about the purpose of military forces and their relationships to the other elements of national power strongly affect grand strategies. For example, if military forces are viewed as a means of last resort to achieve national objectives, then grand strategies will reflect that belief. If one believes that “a well-organized, well-planned, and well-flown air force attack will constitute an offensive that cannot be stopped,”(16) then wartime strategies such as those used against Germany in World War II will reflect that belief. If one believes that “the best antitank weapon is a better tank,” then tactics used against armor will reflect that belief.(17) Doctrine, then, provides a basis for all levels of strategy.

Sometimes doctrines and strategies are so intertwined that they go by the same name. One example is the strategy and doctrine of deterrence. Most of us who ascribe to the belief that an attack on a nation that can respond with certain devastation would not only be foolhardy but suicidal believe in the deterrence doctrine. This belief has been converted into a plan or strategy that relies on our Triad of nuclear forces to deter nuclear war. Later we will see a similar metamorphosis in one of the space doctrines.

Because doctrinal beliefs come in many levels of abstraction, it is helpful for the purposes of this book to categorize doctrinal beliefs. Lt Col Dennis Drew has identified three levels or categories of doctrinal beliefs--fundamental, environmental, and organizational.(18) The first category, fundamental doctrine, includes beliefs about the purposes of the military, the nature of war, and the relationship of the military instrument of power to other power instruments. He includes in this category beliefs that apply to all military forces, such as the so-called principles of war. Fundamental doctrine is the most abstract and therefore is rarely published as official doctrine.(19) A second category is environmental doctrine or the best way to employ forces in a particular environment (land, sea, air, or space). This type of doctrine often includes the word *power* in its title (e.g., land power, sea power, air power, and space power), and although it is less abstract than fundamental doctrine, environmental doctrine is also difficult to publish officially.(20) According to Drew, the least abstract category of doctrine is organizational

doctrine. This doctrine deals with the organization of military forces and defines the missions of the various organizations. Because it legitimizes organizations and what they do, organizational doctrine is very concrete and is almost always published.(21)

The focus of this book is on an environmental doctrine for space, or, in the vernacular, a space power doctrine. However, since beliefs about the best way to employ space forces are explicitly linked to--in fact, result from--one's fundamental doctrinal beliefs, this chapter describes several fundamental beliefs that influence the author's view of space power doctrine. Particularly, it explores those differences in fundamental beliefs that impact the analysis of the four schools of doctrinal thought concerning the best way to employ space forces. Before undertaking this task, we must define space power and space forces.

Space power is an element of national power analogous to air, sea, and land power. Although standard military definitions of these terms do not seem to exist, military thinkers from Mahan to Mitchell have offered definitions with similar characteristics. First, land, sea, and air power are elements of national power that enable a nation to exert influence through use of a particular medium. Space power, it follows, is the ability to use the space environment in pursuit of some national objective or purpose. Second, this purpose may be purely military, such as the collection of surveillance data, or nonmilitary, such as earth resource data collection or civilian communications. Third, all four elements of national power embody not just military forces but civilian capabilities as well. For instance, Gen H. H. "Hap" Arnold described air power as the total aeronautical capabilities of a nation. Admiral Mahan even included the nature of a country's political institutions as a determinant of a nation's sea power. By extension, the space shuttle, a civilian vehicle, along with the political structure that allowed its development, contributes to US space power. A definition that includes these three characteristics is that *spacepower is the ability of a nation to exploit the space environment in pursuit of national goals and purposes and includes the entire astronautical capabilities of the nation*. A nation with such capabilities is termed a *space power*.(22)

By this definition, the United States is a space power whether or not it ever deploys space forces or even military "space systems." The ability to predict severe weather that may affect the United States is an example of space power in that it satisfies a national goal to maintain the well-being of the citizenry. The technological capability to build communication satellites for the rest of the world is an element of our space power that contributes to our economic well-being. Other nonmilitary examples could be cited ad infinitum, underscoring the point that the question to be addressed in this book is not whether the United States should be a space power, because it definitely is. The question must be restated to ask, "Should space forces be developed and deployed?" Put another way, "Should there be a military component to US space power?"

The military component of space power is provided by space forces. These forces may be capable of destructive acts or, like many types of land, sea, and air forces, only provide support to the destructive elements. For example, airlift forces provide support services that are essential to combat capability but do not directly inflict combat casualties. Airlift forces also have a nonmilitary function in that they are capable of providing humanitarian services (disaster relief, rescue, etc.). Most current military space vehicles fall into the support category and can also be used in peaceful activities. For instance, military communication satellites can be used to warn of

natural disasters. Furthermore, space forces may include manned or unmanned vehicles just as air forces are a mix of manned aircraft and unmanned ballistic and cruise missiles. Moreover, space forces have distinguishing characteristics because they are designed to operate in the space environment. For example, the lack of an aerodynamic design distinguishes most space vehicles from air vehicles. Space forces also have that characteristic of orbital motion that distinguishes them from ballistic missiles that pass through the space environment but do not reside there, and from high-flying aircraft that operate on the edge of but not in the environment. In sum, space forces are those vehicles designed to operate in the environment for long periods of time.

By this definition, the United States currently employs space forces even though we have no weapons in space. Military weather satellites are space forces just as surely as the US Air Force weather reconnaissance aircraft are air forces. Although the phrase *space forces* has an aggressive sound, it is used here in as common a manner as “sea,” “air,” and “land forces.” Because the United States already has space forces according to this definition, the purpose of this book should be restated to ask, “What type of space forces should be employed,” which is another way of saying, “What is the best way to employ space forces.”

Military space advocates often take umbrage with a definition of space forces that includes only those things operating in the environment They ask whether a ground-based antisatellite (ASAT) weapon should be part of a space force. The question highlights the differences between environmental and organizational doctrines. What forces would be assigned to some organizational entity such as a space force or a space command is a very legitimate question in the organizational doctrinal category, but one that should be addressed after the question of the best way to employ forces in the environment has been answered. In fact, the organizational doctrine question will, by and large, be solved once the environmental doctrine is determined. To address the environmental doctrinal question, one must start with a class of definable things to examine, preferably things with like characteristics. For these reasons, I will define space forces in the restrictive sense as used earlier.

Throughout this book the terms *air*, *land*, and *sea forces* are used in the same restricted environmental or generic sense. For example, air forces are those that operate above ground, within the atmosphere; sea forces are those forces that float on or beneath the ocean's surface; and land forces are those that move on terra firma. I have no wish to remove air forces from today's US Navy or helicopters from the Army only to have a definable class of things under each of the force categories.

Whereas organizational doctrine becomes clearer as environmental doctrine is determined, environmental doctrine is deeply influenced by fundamental doctrine. Four beliefs that can be classed in the fundamental category are so important to the treatment of a space doctrine that they require discussion in this introductory chapter.

The first of these beliefs involves the existence of a rational purpose for a full-scale nuclear exchange between the superpowers. One can argue that history illustrates that a rational purpose is not a necessary condition for a war --World War I being a significant example. However, assuming rationality for a moment, can there be a purpose for an all-out nuclear exchange if both sides have a sufficient capability to destroy the other in a retaliatory mode? If one believes the

Clausewitzian doctrine that war is politics carried on by other means, then what political objective can be satisfied by mutual suicide?(23) If one believes that the purpose of war is to achieve a better state of peace, then what present condition would be so terrible that the aftermath of a nuclear holocaust would be better, even to the survivors? If the objective of war is to destroy the enemy's armed forces, then this objective could be satisfied by a massive nuclear exchange but at enormous collateral cost. Starting with anybody's definition of the purpose of war, there seems no possible rational purpose for two countries to commit mutual suicide.

The aforementioned should not be taken as an argument that there cannot be a full-scale nuclear war but rather as a means of setting the stage for expectations of certain rational behaviors from the superpowers as a basis for a doctrinal examination. Since both superpowers acquired nuclear weapons and delivery capabilities, they have behaved very rationally, particularly in situations that could have led to nuclear confrontation. In fact, the superpowers have taken great pains to avoid direct confrontation particularly in situations where critical national interests were at stake. For example, the United States has avoided direct involvement in relationships between the Soviets and their sometimes unwilling Warsaw Pact allies. The Soviets backed off their introduction of offensive missiles in Cuba when the United States demonstrated that the issue was considered critical to US national interests. This same sort of rational behavior to avoid confrontations that could lead to a full-scale nuclear war should be expected to surround the conduct of superpower affairs in space. For example, some have argued that if one of the space powers deployed a space-based defense against ballistic missiles, the other would have to go to any extent, including a full-scale nuclear exchange to stop the deployment. This logic has many faults, the primary one being the assumption that the disadvantage of losing a deterrent capability is somehow overcome by starting a nuclear war. Thus, one of the fundamental beliefs underlying this work is that both the superpowers have a stake in the deterrent strategy and both sides will avoid nuclear war as long as the other's retaliatory capability makes victory uncertain.

A second basic belief involves the rapidity of technological progress in weaponry. The military, civilian leadership, and citizens of this country place great faith in the rapidity of technological change applied to warfare. It is commonly believed that new weapon systems are just short lead times ahead if Manhattan Project levels of effort are expended. Furthermore, conventional wisdom holds that failure to produce these systems on the expected schedule is the result of bureaucratic bungling, incompetence, red tape, and so forth. Although not a weapon system, the space shuttle illustrates this phenomenon. The prevailing attitude in the press after the first flight seemed to be “Why did it take so long?” or “How did NASA lose the on-time, on-schedule capability demonstrated during the moon program?”(24) Delays in the development of the space shuttle were attributed to everything but the enormous technological difficulties that had to be overcome.

This book is based on a more pessimistic view of the rapidity of technological progress. The reasons for this pessimism could be the subject for a separate book, and space is available here to only enumerate some of the reasons. First, the experience base for this belief (military history) indicates that technological progress in weaponry has always been slower than it should have been.(25) For example, none other than General Arnold countered the myth that air power progress was only restrained by Army “bungling” and lack of foresight when he stated, “Despite popular legend, we could not have had any real air power much sooner than we got it.”(26)

Second, even though technological progress has accelerated, the acceleration has affected both the weapon and possible countermeasures, which slows down the development process and requires the final weapon to be more complex than expected. Third, as Alvin Toffler points out, the technology must be assimilated by the user.(27) Assimilation takes time, particularly when the consumer is the relatively conservative military profession. As Admiral Mahan said of this phenomenon in a simpler time, "Improvement of weapons is due to the energy of one or two men, while changes in tactics must overcome the inertia of a conservative class."(28) This pessimistic belief concerning the rate of technological progress in weapon systems cannot be quantified--that is, we cannot say it will take Xpercent longer than expected--nor does it mean that there will not be progress or that we should not spend money to make progress. It means only that progress will not be as rapid as we expect.

A third fundamental belief influencing doctrinal development is that there is continual fluctuation in the balance between offensive and defensive weaponry. As argued above, technological progress is slow, but it is often concentrated in efforts to counter the prevailing weaponry of the times. History and current events provide many examples--the naval gun and armor "races" that took place about the turn of the century, the impact of radar on the bornber-invincibility doctrine of the 1930s, and the possible impact of stealth technology on current radar-based defenses. Based on this belief, technological progress will ultimately (but later than advocates expect) provide the bullet that will stop a bullet (ballistic missile defense). In addition, the belief argues against the development of an ultimate weapon or, at least, a weapon that predominates for very long.

The final fundamental belief that supports the thesis of this book is that nations will continue to resort to violent means to achieve political objectives, and that these warlike means are more likely to be used against nations that have corresponding military weaknesses. One could cite examples throughout history as evidence to support this view. In addition, one could also point out that the times of prolonged peace resulted when one or two peaceful nations were strong enough to impose peace on lesser nations. This does not mean that peace treaties are not to be supported but that they should be viewed from a realistic vantage of human nature rather than a "Pollyannaish" view of the goodness of all men.

Based on these fundamental beliefs, this book analyzes four of the currently proposed environmental doctrines (space power doctrines) that portend to be the best way to employ space forces. It accomplishes this task by first defining the characteristics of the military vehicles that can or could operate in the environment (chapter 2). These characteristics serve both as a summary of the military experience with space forces and as a basic language for the examination of these four doctrinal schools of thought (chapters 3 through 7). These schools include the "peaceful-use school" which objects to phrases like *space forces* and *space power* because advocates believe that these aggressive words should not be applied to space. Also among the schools examined is one that believes that space forces will change both the grand and military strategies that are used today in support of national objectives. The analysis of these four belief structures or doctrines provides the foundation for the synthesis of a space power doctrine (chapter 8).

NOTES

1. In 1982 I briefed Gen James V. Hartinger, who was to become the first commander of Space Command, on the basic thesis of this book. General Hartinger cautioned me on my use of phrases such as *space forces* and *space power*. Based on his experience in giving numerous speeches on space to the general public, he said that such phrases would not be very favorably received by the American public.

2. Philip J. Klass, *Secret Sentries in Space* (New York: Random House, 1971), 122-29. Klass claims that the secrecy surrounding certain US military space activities was in reaction to Soviet protests about "spy satellites." It was not until 1978 that the United States admitted that it possessed photoreconnaissance satellites. In remarks during a ceremony to present the Congressional Space Medal of Honor to six astronauts, President Jimmy Carter stated: "Photo-reconnaissance satellites have become an important stabilizing factor in world affairs in the monitoring of arms control agreements. They make an immense contribution to the security of all nations." President Carter, "Remarks at the Congressional Space Medal of Honor Awards Ceremony, 1 October 1978," *Weekly Compilation of Presidential Documents*, 9 October 1978, 1684-87.

3. After the first space shuttle launch, there were numerous newspaper articles warning that the military was attempting to wrest control of the space shuttle from NASA with an ultimate purpose of militarization of space. For example, see "Can Weapons Be Kept Out of Space," *Long Island Newsday*, 21 April 1981, 5; and Robert Cooke, "The Pentagon Eyes the Shuttle," *Boston Globe* 17 May 1981, 23.

4. Office of the General Counsel, National Aeronautics and Space Administration, "National Aeronautics and Space Act of 1958 as Amended and Related Legislation," Washington, D.C., 1 July 1969, 1.

5. Ibid., 4.

6. I am not alone in this observation. As he was assuming the position of director of plans, Headquarters USAF, which has the responsibility for Air Force doctrine, Maj Gen Perry M. Smith stated, "Another weakness which I noted on the part of our officers was a general inability to understand and articulate Air Force doctrine." Letter, Maj Gen Perry M. Smith (HQ USAF/XOX) to Lt Gen Charles G. Cleveland, commander, Air University, 10 September 1981. Furthermore, several conclusions of a United States Air Force Academy-sponsored space doctrine symposium indicate a similar problem: "No common, accepted definition of doctrine resulted from the roundtable discussions. Before future discussions of space operations doctrine can be fruitful, a better understanding of doctrine and its applications must be developed." *Military Space Doctrine--The Great Frontier The Final Report from the Military Space Doctrine Symposium, 1-3 April 1981*, ed. Paul Viotti (Colorado Springs, Colo.: United States Air Force Academy), 13-15.

7. Air Force Regulation (AFR) 1-2 defines doctrine as those "fundamental principles, developed from experience or theory, [that] guide the USAF in support of national objectives." This regulation goes on to say that "doctrine is what we believe concerning the use of aerospace forces." According to Air Force Manual (AFM) 1-1, "Basic doctrine embodies fundamental ideas about the use of air power" and "Doctrine consists of rules for organizing, directing, and employing aerospace forces." AFR 1-2, *Assignment of Responsibilities for Development of Doctrine and Mission Employment Tactics*, 22 November 1978, 1-2; AFM 1-1*, Functions and Basic Doctrine of the United States Air Force*, 14 February 1979, vii.

8. AFM 1-1 lists 11 principles of war--objective, offensive, mass, economy of force, surprise, security, unity of effort, maneuver, simplicity, timing and tempo, and defense (AFM 1-1, 14 February 1979, 5-6 to 5-8). US Army Field Manual (FM) 100-1 lists nine principles of war--objective, offensive, mass, economy of force, maneuver, unity of command, security, surprise, and simplicity. FM 100-1, *The Army*, August 1981,13-17.

9. Professor I. B. Holley, Jr., "An Enduring Challenge: The Problem of Air Force Doctrine," *The Harmon Memorial Lectures in Military History, Number Sixteen* (Colorado Springs, Colo.: United States Air Force Academy, 1974).

10. Lt Col Dennis M. Drew, USAF, "Of Trees and Leaves: A New View of Doctrine," *Air University Review*, January-February 1982, 40-48.

11. After publishing *The Influence of Sea Power upon History, 1660-1783,* Mahan wished to remain at the Naval War College to work on subsequent volumes, but was told by the chief of the Bureau of Navigation, who wished to transfer him elsewhere, that "it is not the business of naval officers to write books." William F. Livezey, *Mahan on Sea Power* (Norman: University of Oklahoma Press, 1947), 10-13.

12. The first official air power doctrine manual was FM 100-20, *Command and Employment of Air Power*, 21 July 1943.

13. The first "space" doctrine manual was AFM 1-6, *Military Space Doctrine*, 15 October 1982.

14. One of the primary differences between the 1955 and 1959 versions of AFM 1-2 was the replacement of the word *air* with *aerospace*. AFM 1-2, *United States Air Force Basic Doctrine*, 1 April 1955; AFM 1-2, 1 December 1959.

15. The first extensive block of instruction on space was included in the Air War College curriculum in the 1981-82 school year. The security classification of space-related topics was a major hindrance to curriculum inclusion.
16. This credo was taught at the Air Corps Tactical School starting in the late 1920s. It was one of the beliefs on which US World War II air strategy was based. Robert Frank Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force, 1907-1964* (Maxwell AFB, Ala.: Air University, 1974), 68-69.
17. After reviewing US experience with antitank weapons in World War II, the Stilwell Board concluded, "The best antitank weapon is a better tank." The North Koreans verified this experience in the initial stages of the Korean War when their tanks were superior to those used by US forces. Maj Robert A. Doughtry, USA, "The Evolution of US Army Tactical Doctrine, 1946-1947," *The Leavenworth Papers* (Fort Leavenworth, Kans.: Combat Studies Institute), 4-8.
18. Drew, 43-47.
19. Ibid., 43-44.
20. Ibid., 44-45.
21. Ibid., 45-46.
22. A collection of air power definitions including those by Gens Billy Mitchell and H. H. Arnold are included in John Cobb Cooper, *Explorations in Aerospace Law*, ed. Ivan Vlasic (Montreal: McGill University Press, 1968), 17-35. Mahan's elements of sea power are contained in Alfred Thayer Mahan, *The Influence of Sea Power upon History, 1660-1793* (New York: Hill and Wang, 1963), 22-77. For another comprehensive definition of sea power, see *Sea Power*, ed. E. R. Potter and Chester W. Nimitz (Englewood Cliffs, NJ.: Prentice-Hall, Inc., 1960), 19.
23. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 87.
24. For example, see "Astronauts Fly Shuttle to Perfect Landing," *Washington Post*, 15 April 1981, 1; and "An End, A Beginning," *Los Angeles Times*, 15 April 1981, 16.
25. For a historical perspective on the reasons why weapons technology develops slowly, see Bernard and Fawn M. Brodie, *From Crossbow to H-Bomb* (Bloomington: Indiana University Press, 1973), 8-13.
26. As quoted in Futrell, 31.
27. Toffler describes the four stages of technological innovation--the creative, feasible idea; its practical application; its diffusion through society; and the generation of new feasible ideas by the diffusion of the old idea. In my view the diffusion step is the most difficult for human beings because it usually requires the acceptance of change. Alvin Toffler, *Future Shock* (New York: Random House, 1970), 2-34.
28. Mahan, 8.

CHAPTER 2

SPACE FORCE CHARACTERISTICS

A definition of the characteristics of space forces is essential to the purposes of this book for several reasons. Initial thinking about space forces was based on an assumption that they are merely high-flying air forces.(1) As a result, the characteristics of air forces were mistakenly used to describe space forces. The term *aerospace* was coined and doctrine was formulated by simply changing *air* to *aerospace* in the Air Force doctrine manuals.(2) The first reason for this chapter is to counteract this "aerospace fallacy" that has been such a hindrance to the development of a space doctrine. A second reason is that terms used to describe force characteristics or attributes actually summarize the military experience that stands behind doctrine. For example, the characteristics of air forces--range, speed, and maneuverability---summarize the military experience that dictates an air power doctrine distinct from land power and sea power doctrine. Likewise, the unique space force characteristics presented here underscore the necessity for a separate space power doctrine. Finally, this chapter provides a common language for the rest of this book.

One encounters several pitfalls in attempting to define space force characteristics. The first could be called the "General Billy Mitchell dilemma": Does one describe the characteristics of today's forces or the characteristics that might develop in the future? Should doctrine be based on technological projections of future characteristics or only on experience?(3) There are no comfortable answers to these questions.

This chapter seeks a middle ground, defining space force characteristics based on experience and conservative technological projections for the next 20 years. If characteristics described herein turn out to be in error, the error should be on the conservative side.

A second pitfall in defining force characteristics is the tendency to view characteristics through the eyes of an advocate. Positive attributes that have a definite military utility are often emphasized, whereas negative characteristics that detract from military value are rarely mentioned. This chapter details both positive and negative characteristics. The reader is urged to keep in mind, however, that books about space doctrine are not written by disinterested parties.

A third pitfall is the fact that characteristics should summarize military experience. No space wars have been fought, and the contributions of space forces to terrestrial wars have been hidden by secrecy dictated by a national policy that has sought to conceal the military use of space. Peacetime experience provides some knowledge of space force characteristics; however, it is somewhat presumptuous to describe the military characteristics of space forces when the military experience they are supposed to represent is meager at best. Therefore, these characteristics should be viewed as proposed attributes that should be refined as they are proved or disproved by military experience.

A final pitfall is the tendency to define the technical capabilities (often in excruciating detail) of current systems as the characteristics of space forces. The emphasis in this chapter is on macrolevel characteristics on the same order of detail as range, speed, and maneuverability used

to describe the attributes of air forces. Like these air force characteristics, the attributes defined are those that provide space forces some unique military utility or those that detract from military utility.

The tentative characteristics described in this chapter stem from three sources--the physical nature of the environment, the logistical problems in deploying and sustaining forces there, and the political/ legal conventions that apply in space.

Environmentally Influenced Characteristics

Not only is there very little military experience with space forces, but there is also very little civilian experience with manned operations in space. Therefore, space is an alien medium to most of us, and those Americans who have visited there measure residency time in days.(4) Furthermore, space is significantly different from the other environments. All terrestrial forces, except subsurface naval forces, operate in earth's atmosphere, which influences the way things move (e.g., through aerodynamic drag and lift), weapon effects (blast), and the utility of man. The lack of an atmosphere is just one of the environmental factors that affect the following space force characteristics.

Global Presence

The characteristic most often attributed to space forces is global coverage. This characteristic stems from several factors. First, space surrounds the other environments. Second, space vehicles operate with a high-altitude vantage that provides a line-of-sight view of large portions of the earth, allowing a single orbiting satellite to "see" enormous areas of the earth.(5) Third, space forces, once in orbit, can sustain altitude without expending fuel. Finally, constellations of vehicles in this encompassing medium, with high-altitude vantage and sustainability, can simultaneously "cover" the entire earth.

To better describe the military value of this attribute, the term *global presence* will be used rather than *global coverage*. Space forces have given the space powers a set of global eyes and ears. Global weather forecasts, which prior to the space age would have required an enormous number of ground-based weather stations, are now routinely available based on satellite-derived data. As an example, television stations routinely reported weather over the Falkland Islands during the 1982 war.(6) In addition, three vehicles in geostationary orbit can provide surveillance of, or communications coverage for, almost the entire earth surface, a capability unattainable through the use of ground observers or air vehicles.(7) A constellation of 24 navigation satellites can be arranged so that an observer anywhere on the earth can be within line-of-sight of three satellites.(8) Once these space forces are in position, they provide the space powers an instantaneous global presence not possible with terrestrial forces.

Quasi-Positional Siting

The nature of motion in space contributes to the global presence characteristic and also causes space forces to be quasi-positional rather than maneuvering forces. Particularly at altitudes above major atmospheric effects, the unpowered motion of space vehicles is predictable for short

periods of time (days or weeks, depending on the nature of the orbit). Given an observation of a space vehicle's current position and velocity, trackers can accurately predict its position and velocity for days into the future by using the laws of physics.(9) Therefore, unpowered space forces have more of the attributes of fixed fortifications whose position is known than of maneuvering forces whose future position is in the mind of the commander.

This is not to say that space vehicles cannot maneuver but that their maneuver is limited by the logistical problems involved in supplying them with fuel.(10) In addition, most space forces cannot deviate significantly from their preferred orbit because their missions are predicated on covering particular areas of the earth. Within the constraints of coverage requirements, future space forces will be able to exploit maneuverability as new technology ameliorates the fuel problem. Until then, they can best be described as quasi-positional forces.

Congregational Tendency

A third environmentally influenced characteristic of space forces is their congregational tendency. For example, the geostationary, sun-synchronous, and Molniya orbits are places where satellites tend to be deployed, due to operational requirements.(11) There is such a crowd of vehicles in the geostationary orbits (more than 127 communications satellites alone) that the International Telecommunications Union assigns spots to preclude radio interference. The widely used near-earth orbits may also be considered unique gravitational zones from the standpoint of the launch energy required to reach them. Within some of these cluster zones or belts are cluster points. For example, heavy concentrations of satellites occur on certain places on the geostationary belt because these places are advantageous for communications purposes.(12) In the future, the moon or the so-called liberation points (unique gravitational places that remain fixed with respect to the earth-moon system) may be other cluster points. The need to avoid danger zones (e.g., radiation and asteroid belts) also contributes to the clustering tendency. The combination of unique gravitational zones and danger zones produces space terrain-like features, and space vehicles tend to congregate in advantageous terrain.

Long-Range Electromagnetic Weapon Effects

A fourth space force characteristic is weaponry featuring long-range electromagnetic kill mechanisms. Although there is no blast effect in the space void, radiations produced by nuclear weapons travel freely there because of the absence of atmospheric attenuation. The radiation flux from nuclear weapons is merely diluted as it moves from the source of the explosion and spreads over more surface area. As a result radiation will be the primary kill mechanism of nuclear weapons in space, and the killing or destruction ranges will be much greater than in the atmosphere.(13)

In the future, directed energy weapons (e.g., laser, radio frequency, or particle beam) may be used in space. Kill ranges of space-to-space directed-energy weapons will also not be restricted by atmospheric interactions with the beam (a major problem with terrestrial use). If such weapons are operationally feasible, they will transmit their killing power at the speed of light over greater ranges than are possible with atmospheric use.(14)

Hypervelocity Kill

Another space force characteristic that derives from the lack of an atmosphere is the hypervelocity kill mechanism. The absence of atmospheric drag permits movements at speeds not attainable in the atmosphere (vehicles in low-earth orbit travel at speeds on the order of 4.7 miles/second).(15) At these speeds, even small masses have enormous kinetic energies that can be used as kill mechanisms for space-to-space weapons. For example, a 4,000-pound automobile would have to travel at almost 270 miles per hour to equal the kinetic energy of a one-pound projectile traveling at 4.7 miles/second. In addition, deorbited projectiles retain much of their velocity and could be used against airborne or surface targets.

Infinite Operating Arena

A final environmentally influenced characteristic is that space forces operate in an infinite arena. We can get some sense of the expanse of the medium by realizing that the distance from earth to geostationary altitude is almost the same as a trip around the earth. In addition, when satellites in geostationary orbits are positioned one degree apart to preclude radio interference, they are actually 400 nautical miles apart. Whereas the terrestrial environments are finite (and seem to become smaller as the range of weaponry increases), space always presents new frontiers. Nations with the most capable space transportation systems will be able to exploit these frontiers for military purposes. In other words, the most technologically capable nations will have more space power because they will be able to achieve technological control of more of this infinite environment.

Logistically Influenced Characteristics

Logisticians often complain that their contributions to the military art are always forgotten until they must tell a commander in the heat of battle that his strategy is not logistically supportable. The logistical influences on space force characteristics, however, cannot be ignored even before the battle. None of the other environments is as difficult to reach. One wag described space flight in nautical terms as follows: Suppose you decide to take an ocean voyage from Europe to America and build a magnificent ocean liner costing millions of dollars for your trip. You sail the ship to within sight of the shore, scuttle it, and take a rowboat the final few miles. Technological advances such as the almost totally reusable space shuttle make this analogy slightly dated. Nevertheless, space travel is the only mode of travel whose cost is measured in hundreds of dollars per pound.(16) Space forces, therefore, have logistical characteristics that are primarily negative attributes.

Logistical Handicap

The first logistically influenced characteristic is that space forces are handicapped in competition for missions with forces in the other environments. Space competes for missions primarily with the other encompassing medium--the air environment. Early space advocates proposed accomplishing traditional air missions from space (e.g., strategic bombing, earth-to-earth spacelift).(17) Logistical constraints soon brought those ideas back down to earth--or at least into the atmosphere. Because space force deployment is so difficult, space forces will only be

deployed when mission advantages can overcome the logistical handicap. Proposed space missions must be weighed against logistical disadvantages with the end result often being that the missions are accomplished, possibly less well, from the other environments. Although technological improvements in space travel may lower the value of the handicap, space forces will always be at a disadvantage from a logistical cost/benefit analysis.

Inaccessibility

A second logistical characteristic is that space forces, once deployed, are largely inaccessible. Although the space shuttle has opened routine access to certain low earth orbits, access to satellites at higher altitudes may be many years in the future. Unlike our terrestrial experience with falling objects, in space, energy is required to go down (lower orbital altitude) as well as up (increase altitude). Or put another way, it costs energy to make the trip both to and from any vehicle that needs repair. Therefore, the economic tradeoffs between transporting parts and repairmen to upgrade or repair a space vehicle and launching new replacement vehicles may not favor the former. As a result space forces have to work perfectly the first time, they become technologically obsolete the moment they are launched, and they cannot be modified to meet new threats.

Lack of Manning

A third logistical characteristic is that space forces are primarily unmanned. Although the space shuttle has revived US manned space operations after a nine-year hiatus, the shuttle provides access only to low altitudes. Furthermore, the unexpected debilitating effects of motion sickness on shuttle crews show that the United States, at least, has much to learn about man's utility in the environment (the Soviets have much more extensive manned flight experience).(18) Our technological prowess at making space robots will also slow down man's application to space missions. The presence of humans beyond the low earth orbits reachable with the shuttle will be an exception rather than the rule for the next 20 years.

Altitude/Security Tradeoff

The final logistically influenced characteristic is that space forces, within the constraints of mission requirements, can trade altitude for security against ground-based threats. The level of effort and the time required to reach a given orbit is directly proportional to the orbital altitude.(19) Deployed space forces have not only paid the price to gain altitude but also have the vantage provided by their position. Ground-based attacking forces have the disadvantage of “climbing” the gravity and atmospheric “hills” (atmospheric drag) under the direct observation of the defending force.(20) Ground-based directed energy weapons would also have to overcome the attenuating effects of the atmosphere to destroy space vehicles.(21) In essence, it is easier to remain king of tall, steep mountains.

Politically/Legally Influenced Characteristics

International law contains rules that define what is acceptable behavior for nations in times of both peace and war. A nation breaking these rules risks consequences ranging from verbal

condemnation to war (or escalation in the level or intensity of ongoing conflicts). In addition to these constraints imposed by the international community, nations prepare for and conduct warfare based on the nature of their political systems. Different sets of rules govern actions in the four environments and affect the employment of forces just as surely as the characteristics of the weapons. Three somewhat interrelated space force characteristics result from political/legal influences. These characteristics are legal overflight of other nations, vehicular sovereignty, and political insensitivity.

Legal Overflight

Based on precedents set by both the United States and the Soviet Union, space vehicles, unlike air vehicles, can legally overfly sovereign territories. In fact, space vehicles cannot be deployed without overflight of sovereign territory, so the acceptance of overflight by the space powers was necessary for the existence of space forces.(22) Based on these precedents, space forces are the only forces that can legally “see” inside another sovereign nation in peacetime.

Nations may attempt to deny space overflight during wartime, but not many conflicts extend into space, either because one opponent lacks space power or because both sides place political constraints on the war. Therefore, this legal-overflight characteristic may be an important force characteristic not only in peacetime but in many wartime situations.

Vehicular Sovereignty

A second political/legal characteristic, one closely related to legal overflight, is that space forces possess vehicular rather than positional sovereignty. Like naval forces on the high seas, sovereignty resides with the vehicle, not the vehicle's location. In other words, space vehicles belong to the nation whose flag they fly. One impact of this characteristic is that space forces cannot rely on borders for security as land, air, and, to some extent, sea forces can. Because natural obstacles often serve as boundaries, land forces often rely on these obstacles as part of the defense. In addition, since boundary crossings are almost always acts of war, land forces behind a boundary receive tactical warning when that boundary is breached. Air forces have similar advantages except when they are over international waters, and naval forces have these advantages while they are in home waters. Space forces have neither the usual defensive advantage nor the warning advantages provided by boundaries. Furthermore, current space forces, with the exception of the space shuttles, cannot even move from international “space waters” to protected sovereign areas like air and sea forces can.

Another impact of vehicular sovereignty concerns the consequences of an attack on the vehicle. While invasions across defined geographical boundaries are unmistakable acts of war, an attack on a sea or air vehicle in or over international boundaries may or may not be considered an act of war. The seizure of the USS *Pueblo* by the North Koreans in 1969 and the subsequent shooting down of a US EC-121 aircraft by the same nation did not result in warlike responses by the United States.(23) The attacker in these cases claimed territorial incursions and that the vehicles were on “spy” missions, which seemed to diminish public support for retaliatory actions. Nevertheless, the point can be made that the consequences of violating a vehicle's sovereignty are less certain than a breach of a nation's borders.

Political Insensitivity

The last political/legal characteristic of space forces is their political insensitivity. This characteristic has both positive and negative aspects. On the positive side, space forces are out of sight and out of mind. They do not require overseas bases, nor are they high-value targets placed in domestic backyards. Thus, space forces are insensitive to many of the political constraints that affect other forces. For example, during the 1970s when the United States withdrew or was chased out of several overseas bases, the lost monitoring capabilities were replaced by space forces.(24) Many proponents of space-based ballistic missile defense see an advantage in the fact that it will not draw enemy fire to home territory. Furthermore, because space forces cannot be seen, their capabilities are easily lent to allies without the political repercussions tied to terrestrial force support.

On the negative side, the same insensitivity may make these forces more vulnerable. Would nuclear weapons more likely be used in the remote, uninhabited space environment? Would the destruction of an unmanned satellite protected only by vehicular sovereignty be cause for retaliatory action?

This set of space force characteristics should be considered tentative, because they are either summaries of our current military experience, which will change with time, or characteristics derived from logical inference that must be continually reassessed. Those characteristics, influenced by the nature of the environment (global presence, quasi-positional motion, congregational tendency, long-range electromagnetic effects, hypervelocity kill mechanisms, and infinite operational arena), will change very slowly or not at all. Logistically influenced characteristics (the logistical handicap, the inaccessibility of deployed space forces, the fact that space forces are primarily unmanned, and the nature of the altitude/security tradeoff) will change more rapidly with technological advances. The most powerful space powers could change the political/legal conventions (legal overflight vehicular sovereignty, and political insensitivity) by mutual agreement, by allowing one space power to predominate, or by becoming involved in a space war.

These characteristics are unique to space forces and thus dictate that space forces have a separate doctrine. The next chapter describes four such doctrines, which differ not so much in their delineation of space force characteristics as in their position as to which characteristic is of the most value in achieving national goals and objectives. In a way, the four doctrines described in the next chapter are like the old parable in which several blind men describe an elephant by each touching a separate feature. The tentative characteristics defined in this chapter are a description of the total space force elephant, which will aid in defining the best way to employ these forces.

NOTES

1. Gen Thomas D. White, USAF, “Air and Space Are Indivisible,” *Air Force Magazine*, March 1958, 40-41.
2. One of the primary differences between AFM 1-2 published in 1955 and its successor published in 1959 was the replacement of the word *air* with *aerospace*. AFM 1-2, *United States Air Force Basic Doctrine*, 1 April 1955; AFM 1-2, 1 December 1959.

3. Robert Frank Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force 1907-1964* (Maxwell AFB, Ala.: Air University, 1974), 29-30.
4. Before the first shuttle flights, only 43 US citizens had experience as astronauts. The most experienced astronauts had just over 2,000 hours in space. Headquarters Administrative Division, Office of Management Operations, National Aeronautics and Space Administration (NASA), *NASA Pocket Statistics*, January 1979, C-6.
5. The percentage of the earth's surface visible from a satellite at altitude *h* (in nautical miles) can be calculated from:

$$A = \left[\frac{1 - \dfrac{3444}{(3444 + h)}}{2} \right] 100$$

For example, a satellite at geostationary altitude can "see" 42.4 percent of the earth's surface. Jorgen Jensen et al., *Design Guide to Orbital Flight* (New York: McGraw-Hill Book Co., Inc., 1962), 771-73.
6. Gordon Barnes of the Cable News Network (CNN) routinely gave weather reports for the Falkland Islands based on satellite-derived data.
7. One geostationary satellite can cover 42.4 percent of the earth's surface (see note 5). Three geostationary satellites positioned 120 degrees apart have a line-of-sight view of almost the entire earth, missing only small areas at the poles.
8. "USAF in Space: The Air Force Satellite Systems," *Air Force Magazine*, June 1982, 52-59.
9. Routine orbit calculation techniques can provide accuracies on the order of 12 kilometers (7.44 miles) or less in positional error over a three-day prediction. Special techniques on "good" orbits can predict satellite positions over a three-day period within one kilometer (.62 miles). Col Robert M. Kronebusch, USAF, "USAF's Roles in Space Surveillance," *Proceedings of the Sixteenth Space Congress*, 25-27 April 1979 (Cocoa Beach, Fla.: Canaveral Council of Technical Societies, 1979), 2-16 to 2-21.
10. Rather than carrying fuel to space there is another choice--extract energy from the environment. The technology to do this has not been widely exploited. Ernst Stuhlinger, "Electric Propulsion Ready for Space Missions," *Astronautics and Aeronautics*, April 1978, 66-77.
11. A satellite in geostationary orbit travels in the equatorial plane in a circular path at an altitude of 19,360 nautical miles. At this altitude, the orbital period is 24 hours, so the satellite appears to hang stationary over a point on the equator even though the satellite is moving in a circular orbit through space. This altitude (19,360 nautical miles) is the only altitude possible for geostationary orbits. At lower altitudes, space vehicles move faster and thus have shorter periods; and at higher altitudes, they move slower and have longer periods. The sun-synchronous orbits are circular orbits whose orbital plane is inclined at almost 90 degrees to the equator (termed *polar orbits* because they pass almost over the poles). With the correct combination of altitude and inclination angle, the satellite will pass over the equator on the sunlit side of the earth at local noon and will continue to do so throughout the year--hence the term "sun-synchronous." The Molniya orbit, named after a class of Soviet communication satellites, is an elliptical orbit with a 12-hour orbital period. The orbital plane is inclined at 64 degrees to the equator with the satellite's apogee (farthest point) in the northern hemisphere and perigee (nearest point) in the southern hemisphere. With this orbital configuration, the satellite spends 23 out of every 24 hours in the northern hemisphere (in an elliptical orbit the vehicle travels slower at apogee than at perigee). For a discussion of the geometry and the advantages of these orbits, see Col Robert B. Giffen, USAF, *US Space System Survivability: Strategic Alternatives for the 1990s*, National Security Affairs Monograph Series 82-4 (Washington, D.C.: National Defense University Press, 1982), 6-11. For a view of the crowding problems in geostationary orbits, see Wilbur L. Pritchard, "The Holdup on Broadcast and Mobile Communications Satellites," *Astronautics and Aeronautics*, September 1980, 40-43.
12. Satellite count is based only on the 1980 population of communications satellites. See Walter L. Morgan, "'Higher and Higher' for Communications, Satellites," *Astronautics and Aeronautics*, September 1980, 56-57.

13. Dan W. Hanifen and William G. Kuller, "Fragility of Space Operations in a Nuclear War" (Paper delivered at the 1981 Air University Airpower Symposium, Kirtland AFB, N.Mex.: Air Force Weapons Laboratory, September 1980), 2-28.
14. For a pessimistic view of the possibility of laser weapons, see Edgar Ulsamer, "The Long Leap toward Space Laser Weapons," *Air Force Magazine*, August 1981, 58-64. For a more optimistic view, see Wallace D. Henderson, "Space-Based Lasers: Ultimate ABM Systems," *Astronautics and Aeronautics*, May 1982, 44-53.
15. Krafft A. Ehricke, *Space Flight*, vol. 1, *Environment and Celestial Mechanics*, ed. Crayson Merrill (New York: D. Van Nostrand Co., Inc., 1960), 287.
16. In 1980, the estimated cost to deliver one pound to low-earth orbit was $455 ($1,000 per kilogram). For comparison the cost to deliver one pound coast-to-coast in an airliner is $2.27 ($5 per kilogram). Ivan Bekey and John E. Naugle, "Just Over the Horizon in Space," *Astronautics and Aeronautics*, May 1980, 64-76.
17. Maj Gen John B. Medaris, commanding general of the Army Ballistic Missile Agency from 1955 to 1958, proposed using "missile transport" to move people and equipment from one place on the earth to another. John B. Medaris, *Countdown for Decision* (New York: G. P. Putnam's Sons, 1960), 162-63.
18. "Nearly one-half of the astronauts and cosmonauts who have flown demonstrate symptoms of space motion sickness." Leonard David, "Make Way for Private Citizens in Space," *Space World*, January 1983, 4-8. The Soviet lead in manned space flight is due to their manned space station, Salyut. For some background, see Rolf Engel, "Soyuz and Salyut: Stepping Stones to a Permanent Soviet Space Station?" *Interavia* 2 (1982): 173-77.
19. Robert B. Giffen estimates a time of three to six hours to reach geosynchronous altitude from earth. Giffen, 38.
20. The basic problem in injecting a space vehicle into orbit is to impart sufficient velocity through engine thrust to achieve the desired velocity and position at engine cutoff. The burnout velocity and position determine orbital parameters. Velocity is "lost" in this process in overcoming the effects of gravity and atmospheric drag. For the German V-2 rocket, gravity losses were on the order of 30 percent of the required cutoff velocity, while atmospheric drag cost 4 percent (i.e., the V-2 designer had to add 34 percent more velocity capability in the engine thrust to overcome gravitational and atmospheric effects). Krafft A. Ehricke, *Space Flight*, vol. 2, *Dynamics*, 520-21.
21. For a discussion of atmospheric effects on laser beams, see Kosta Tsipis, "Laser Weapons," *Scientific American*, December 1981, 51-57. More technical details are available in M. Callaham and K. Tsipis, *High Energy Laser Weapons. A Technical Assessment*, Report no. 6, Science and Technology for International Security (Cambridge: Massachusetts Institute of Technology, 1980).
22. Except for vehicles in the geostationary orbits, all space vehicles, by the very nature of orbital motion, must cross earthly boundaries.
23. House, Committee on Armed Services, Special Subcommittee on the USS *Pueblo, Inquiry into the USS Pueblo and EC-121 Plane Incidents*, Report, 94th Cong., 1st sess., 28 July 1969, 1624.
24. In 1980, Secretary of the Air Force Hans Mark noted that there was a trend to replace overseas observation stations lost during the 1970s with satellites. House, Committee on Science and Technology, Subcommittee on Space Science and Applications, *United States Civilian Space Policy*, Hearings, 96th Cong., 2d sess., 23-24 July 1980, 93, 94, and 107.

CHAPTER 3

SPACE DOCTRINES

'There is no space doctrine."

"We need space doctrine."

'The Air Force needs to get its doctrinal house in order."

These were some of the conclusions of the Air University's Airpower Symposium conducted in 1981.(1) A few months later, another space doctrine symposium at the Air Force Academy was reaching similar conclusions.(2) These conclusions were not totally correct because there was a space doctrine, one that governed the employment of space forces even though it had not been officially published. The symposia attendees were correct in their criticism, however, because the doctrine, in effect, was a nondoctrine: that space should be a sanctuary, free from military forces. It is doubtful that many of the attendees at either space doctrine symposium would have accepted the notion that the best way to employ space forces was not to have them.

In addition to this "sanctuary" doctrine, there were three other basic belief structures concerning space force employment voiced at these symposia. Since these belief structures (or schools of doctrinal thought) were even more enigmatic than the sanctuary doctrine, the resultant debate centered on how to organize space forces into a space command and what space technologies should be pursued. Most attendees, including this one, did not realize that the differences of opinion on possible space organizations and what technologies to fund directly resulted from fundamental beliefs that were never openly discussed at these meetings. These beliefs still are largely hidden players in the ongoing space doctrine debate.

This chapter describes the four main schools of doctrinal thought using the force characteristics defined in the last chapter. The doctrinal schools are presented for what they are--honestly held beliefs. They are described in a nonjudgmental manner as articulately as I can describe them (knowing that I will never be able to present the beliefs to the satisfaction of the disciples). Later chapters analyze each of these belief structures. Before describing the doctrinal schools, we need a conceptual framework for analyzing these doctrines. This framework can be derived from the almost analogous air power doctrinal debate that occurred early in this century.

After World War I, there was an extensive debate concerning the value of the airplane as a warfighting instrument. On one side in this debate were those who argued that the air arm's only value was to support the traditional combat arms. In 1924 the Army chief of staff, Maj Gen John L. Hines, stated, "I am of the opinion that the Air Service, because of the limitations imposed by natural laws on the operation of aircraft as well as the necessity for unity of action, will always be an auxiliary arm or service.(3) At the other extreme were the air power enthusiasts, such as the Italian air strategist, Giulio Douhet, who believed that a nation which established command of the air could overcome the deepening stalemate in land warfare that characterized World War I.(4)

The fundamental differences in these views were based on the question of the military value of air power, and different perceptions of value led ultimately to disagreements as to how air forces should be organized. Between the questions of value and organizational structure were other important and related doctrinal questions. One intermediate issue was the nature of future warfare. Was the infantry still the backbone of the attack, with the role of the other arms to help it reach the enemy? Or could air power be decisive, as Gen Billy Mitchell argued? A third issue, how to employ air forces, depended on the advocates' beliefs as to the value of the forces and the nature of war in the environment. Once the issues concerning military value, the nature of war, and force employment were resolved, then the organizational question could be addressed.

This example does not demonstrate that space forces will follow an evolutionary pattern similar to air forces, but it does suggest a useful conceptual framework for analyzing space doctrines. We should examine beliefs about the value of space forces, the nature of space wars, employment doctrine, and organizational arrangements. When we do this, four identifiable belief structures or schools of space doctrine emerge, each of which starts with different assumptions about the value of space force.

Military Value of Space Forces

The first school of space doctrine has already been labeled the sanctuary school. A fundamental tenet of this school is that the primary value of space forces is their capability to "see" within the boundaries of sovereign states. This value stems from the space vehicle's legal overflight characteristic. Proponents of sanctuary doctrine argue that past arms limitations treaties could not have been consummated without space systems that serve as the "national technical means of treaty verification."

Moreover, the prospects for any future treaties would be extremely dim without the ability of space systems to fulfill President Eisenhower's dream of verification through open skies. Thus, space systems have had a tremendous stabilizing influence on relations between the two superpowers. Finally, these advocates caution that overflight is a granted right that nations have not attempted to deny and that any proposed military use of space must be weighed against the possible loss of peaceful overflight. This train of thought leads to the conclusion that the only way to maintain the legal overflight characteristic is to designate space as a war-free sanctuary.(5)

A second school of thought as to the value of space forces emphasizes their lack of survivability. The basic tenet of this school is that space systems are inherently less survivable than terrestrial forces. Several factors undergird this belief. First is the long-range weapon effects in the space environment, coupled with a belief that nuclear weapons are more likely to be used in the remoteness of space. Second, the quasi-positional nature of space forces and their vehicular sovereignty imply that space forces cannot rely on maneuverability or terrestrial barriers to increase survivability. Finally, the negative aspect of space forces' political insensitivity creates uncertainty about the political implications of an attack on space forces (e.g., would we go to war if a satellite were destroyed?). Advocates of the survivability school [A more appropriate name would be vulnerability school. However, survivability is more commonly used in reference to this train of thought in order to accentuate the positive. That is, it is more positive to improve

survivability rather than reduce vulnerability.] have serious reservations as to the military value of space forces. They agree that space forces can do certain military functions (e.g., communications and weather data gathering) more economically and efficiently in peacetime than other forces. They believe, however, that space forces must not be depended on for these functions in wartime because they will not survive.(6)

A third school harkens back to the old military axiom that domination of the high ground ensures domination of the lower lying areas. Disciples of this “high-ground” school advocate a space-based ballistic missile defense (BMD). They argue that the global-presence characteristic of space forces combined with either directed-energy or high-velocity-impact space weapons provide opportunities for radical new national strategies. In their view, space-based defensive forces can reverse the current stalemate caused by the preeminence of the offense and create either an offensive-defensive balance or a preferred defensive stalemate. This rebalancing would allow replacement of the flawed strategy of assured destruction with one of assured survival. Whereas the next school believes space and terrestrial forces are coequal, the high-ground school believes space forces will have a dominant influence.(7)

A fourth doctrine, the control school, declines to place an exact value on space forces and only suggests their value by using air power and sea power analogies. For example, according to Gen Thomas A White, “Whoever has the capacity to control the air is in a position to exert control over the land and seas beneath. I feel…whoever has the capacity to control space will likewise possess the capacity to exert control over the surface of the earth.”(8) Others argue that there are space lanes of communications like sea lanes of communications that must be controlled if a war is to be won in the terrestrial theaters. Control school advocates argue that the capability to deter war is enhanced by the ability to control space and that, in future wars, space control will be coequal with air and sea control.(9)

These four belief structures concerning the value of space forces do not necessarily lead in different directions. The sanctuary and survivability schools, for example, have much in common. The former would not deploy high-value, conventional-war capabilities to space because it would tempt an opponent to violate the sanctuary. The latter would not deploy these forces because they are not survivable. The control school believes that whatever the value of space forces, it accrues to the contestant who controls the environment. Control and high-ground schools may merge if space forces have the predominant value envisioned by the latter. However convergent these beliefs may eventually become, there are significant differences in the various schools' views about the nature of space wars.

The Nature of Space Wars

The sanctuary school attempts to maintain space as a war-free zone. According to its advocates, the primary value of space forces is their ability to reduce the probability of global nuclear war. At all levels of conflict short of global nuclear war, space forces retain their value only if the environment remains a sanctuary. If one side loses the ability to view the other's territory, a low-level war is more likely to escalate to nuclear levels. If one side destroys the other's missile-attack warning system, for example, the blinded nation might feel compelled to make a nuclear strike. In sum, if both sides have the ability to view the other, surprise attacks and

miscalculations are less likely. Based on these arguments, there is no possible advantage to be gained in space wars at the lower levels of conflict; and, after the start of a global war, space forces have lost their primary value. Therefore, space must remain a sanctuary.(10)

Based on their belief that opponents can negate each other's space forces if they are willing to pay the price, the survivability school sees space wars as tit-for-tat affairs. The only defense is to hold the enemy's space forces at risk. If the enemy negates a given capability, the United States must be able to retaliate in kind. Each side holds the opponent's space forces hostage and must not let the value of the hostages or the capability to take hostages become too unequal.(11)

Unlike the survivability school, which believes wars are still won or lost in the lower environments, the high-ground school believes wars will be won or lost in space. Advocates argue that the strategic value of space-based BMD systems will be so monumental that future global nuclear wars will be decided by who wins the space battle. If only one side possesses these assets, the balance of power tilts toward that side. If both sides deploy similar systems, then one side's BMD system must be destroyed before ballistic missiles can be employed. The loser of the space battle will be at such a disadvantage that capitulation could occur without nuclear weapons being used. The high-ground school believes that a nation's military “center of gravity” will move to space with a BMD system and that war's focus also will move to space. In this view, the end result will be positive because wars will be moved to a remote, uninhabited environment.(12)

In contrast, the control school views space warfare as very similar to air warfare. The first objective is to establish some measure of control in the environment. This might be done on an as-needed, where-needed basis, or on an ultimate control (i.e., space superiority) basis. If possible, terrestrial forces will be supported while control of the space environment is being established, but space control is the first priority. Once control is established, the weight of the effort is shifted to support the terrestrial forces. The primary function of space war is to ensure that friendly terrestrial forces have the benefits derived from the space environment and that enemy forces are denied those benefits.

Employment Doctrine

The employment doctrine of the sanctuary school is designed to maintain space as a war-free refuge. Space forces (or, more aptly for advocates of this doctrine, space systems) must be not only nonaggressive but also nonbellicose in order to maintain their primary value. Treaties such as those which ban nuclear weapons or BMD systems from space are beneficial from this doctrinal viewpoint; ground- or space-based antisatellite (ASAT) weapons are destabilizing and should also be banned through treaty negotiation.(13) To maintain a nonbellicose status for these forces, space systems that have or support direct warfighting capabilities should not be deployed, and data collected by national systems should not be disseminated to tactical commanders (in order to downplay the warfighting capability of space systems). Space systems that provide direct support to tactical commanders are looked on with disfavor because they might tend to draw fire to the sanctuary.(14)

The sanctuary doctrine results in two types of space activities--visible and invisible. Visible activities have a decidedly peaceful flavor and are conducted by nonmilitary organizations using “civilian” astronauts and vehicles pursuing scientific and exploratory goals and objectives.(15) Benefits are widely shared on an international basis (which helps to foster international acceptance of overflight rights). In contrast, activities relating to national security are largely invisible. Even if these activities are nonaggressive and nonbellicose the appearance of military value must be avoided. National sensitivities must be considered. Public dissemination of data, even though nations have tacitly agreed that it can be collected, would be such an affront that the target nation might deny overflight rights because of public outcry.(16)

The employment doctrine of the survivability school strongly reflects the belief that an enemy willing to expend the effort can destroy or neutralize friendly space forces. One impact of this belief is that space forces should not be relied on for critical warfighting capabilities. Because the enemy's denial efforts will be directly related to the military value of friendly space forces, complete reliance on high-value space forces is unsound strategy. This doctrine emphasizes redundancy. Similar capabilities must exist in both terrestrial systems and space forces, even if space forces can perform the function more effectively, efficiently, and economically. Redundancy reduces the value of space forces, making them less likely to be attacked, and provides backup capabilities if they are destroyed.

The survivability doctrine affects the decision as to which forces are deployed and it strongly influences how they are deployed. Passive survivability measures are key elements of this doctrine, not because space forces can be made “survivable” but because these measures raise the enemy's ante. Altitude is security because it increases the cost of the enemy's destruction efforts. Low earth orbits should be avoided, if possible, and every effort should be made to station satellites in orbits above geostationary altitude. In fact, the geostationary cluster points should be avoided because clustering might provide single-shot, multiple-kill opportunities to the enemy. Single-mission satellites are preferred to multimission ones, to complicate the enemy's targeting. In sum, passive survivability measures can make the effort required to destroy space forces disproportionate to the advantage gained. Therefore, the criterion to judge whether a system should be deployed is the enemy's cost to destroy it.

The final impact of the survivability doctrine is that it gives ASAT weapons an offensive rather than a defensive role. Space-based weapons that can defend space assets are victims of the survivability dictum. They would be of such value that they would be prime targets for attack; and because of their inherent lack of survivability, they could be negated fairly easily. On the other hand, ground-based ASAT systems cannot defend friendly assets, yet, they are useful in holding the enemy's space forces at risk. The key to deployment of these offensive ASAT systems is to have cheaper, more capable weapons than the other side. In other words, the enemy will be deterred if we have a better capability to retaliate.(17)

The high-ground employment doctrine focuses on the deployment of space-based antiballistic missile systems. Advocates argue that in addition to their primary function these systems have built-in space control capabilities. Any system that can kill ballistic missiles before they reenter the atmosphere will have the capability both to defend friendly space forces and to deny the environment to the enemy. In this view, these systems could be used in a space blockade role to

destroy the enemy's launch systems before they are able to inject their satellites. Many advocates argue further that space-based directed-energy weapons have tremendous capabilities against high-flying aircraft and that employment of these weapons leads to control of not only the space environment but also the high-altitude portion of the air environment. Based on this reasoning, the first nation to deploy these weapons can gain unquestioned strategic advantage by removing the opponent's nuclear umbrella.(18)

The control school's employment doctrine reflects concepts that its advocates believe are historically proved. Control is a two-part concept; it includes the ability to defend friendly forces and to deny the use of the environment to enemy forces. Adherents argue that though it may not ensure survivability, active defense raises the enemy's uncertainty far above calculating the effect of passive survivability measures (hardening, decoys, etc.) on kill probabilities. Furthermore, the uncertainty caused by the mere presence of defensive forces acts as a deterrent. Defensive forces will attract enemy fire, but this is desirable because it pits strength against strength rather than strength against weakness, as does the concept of retaliation in kind.(19) From the control viewpoint, defensive forces are obviously priority assets; but the control doctrine also gives rise to distinctive concepts as to how noncombatant space forces should be deployed. Whereas the survivability school weighs the military value of a given capability against the effort required to negate that capability, the control school defends the asset according to its value. Thus, space force clustering could be advantageous because it might simplify the defensive problem. In fact, some advocates have proposed the so-called Panama Theory: that there are strategic places (geostationary orbits, libration points) in space that have military value similar to the chokepoints in the sea environment (e.g., the Panama Canal), and these strategic places must be controlled.(20) High-value assets might be defended individually, whereas strategic chokepoints might be provided an area defense.

The second part of the control concept requires the capability to deny use of the environment to the enemy. Friendly forces must have the capability to deny the enemy his space lanes of communications. This may be done by using a combination of space-based and terrestrial forces. Friendly space forces or ground-based ASATs may destroy enemy forces in space. Depending on political constraints, other terrestrial-based forces could destroy launch capabilities, factories, and the like.(21)

Organizational Beliefs

Air power history also provides a perspective for viewing space force organizational issues. Two organizational issues confronted early air power pioneers. One question was how to organize the combat forces. Should air forces be organized like the ground component and assigned to a commander with a limited geographic area of responsibility? Or do the speed, range, maneuverability, and flexibility characteristics of air forces dictate that they would best be employed under some other organizational structure? According to current Air Force doctrine, the answer to this question is the concept of centralized control.(22) The second question was how to organize a bureaucratic structure that would serve as the advocacy base for air power. This issue was related directly to the question of the warfighting value of air forces. If the air arm was an auxiliary or service function, then it would compete for funds at the same bureaucratic level as other service functions. Billy Mitchell argued that the real question was

“whether air power is auxiliary to the Army and Navy or whether armies and navies are not actually auxiliary to air power.”(23) In Mitchell's view, air forces should have had a higher position in the bureaucratic power structure than the Army or Navy. Mitchell's views notwithstanding, the rise of air forces from the Air Service to the Air Corps to a separate service shows how the increasing assessment of military value improved the position of the air forces in the bureaucratic advocacy structure.

This nation currently faces the same types of organizational questions concerning space forces. The air power precedent does not mean that space forces must follow the Air Force pattern, but it shows the relationship between values and organizational structures. The beliefs of the various schools of thought lead to different views on how to organize space forces.

The sanctuary school has distinctive views about both operational and advocacy organizations for space forces. Its proponents believe that because space must remain a war-free sanctuary, an operational organization to employ space forces is not required. In fact, such an organization would endanger maintenance of the sanctuary because it implies that the environment will be used for military activities. This school, therefore, sees no value--indeed even an inherent danger--in the establishment of an operational organization to employ space forces.(24)

The advocacy structure for the sanctuary school is already at the highest levels of government, and a military advocacy structure is not required. Space systems designed to support treaty monitoring are now advocated and funded above the military service level. Not only is a military advocacy organization unnecessary, but it also presents a danger to the sanctuary doctrine because it might urge deployment of warfighting capabilities. The sanctuary school, then, sees both operational and military advocacy structures as unnecessary and dangerous.(25)

The survivability school's beliefs lead to other organizational structures. According to this doctrine, an operational organization charged with space force command and control has much to offer. If space forces are to be employed in tit-for-tat battles, then someone must be in charge. Some organization must determine which friendly forces are threatened and which enemy forces are vulnerable; and if passive survivability measures are to be effective, some organization must orchestrate their use. Therefore, the survivability school usually favors a unified or specified command as the operator.

According to the survivability school's beliefs, the correct space force architecture must be advocated, and a decentralized advocacy structure inhibits the proper architecture. This advocacy structure must not forget that the warfighting value of space forces is limited by their inherent vulnerability; therefore, the advocacy structure must be at a command level where the space mission can be weighed against other Air Force missions.

Organizational structures resulting from the control school and the high-ground school are very similar. Both schools agree that the characteristics of the forces dictate that a single operational entity exercise centralized control of forces.(26) The major difference between the two schools centers on the advocacy organization and on the question of military value. The high-ground school argues that the Air Force organizational imperative, which focuses on “air force” things (bombers, fighters, etc.), will never allow exploitation of the space medium. In fact, many argue

that space-based ABM systems could be deployed in a relatively short time if the Air Force were willing to trade B-1s, C-5s, or MXs for this capability. Accordingly, the only way to overcome the organizational advocacy problem is to establish a Space Force as a separate service.(27) The control school, on the other hand, doubts that the technological capabilities of space forces will ever match the expectations of the high-ground school. In addition, most of the control school's advocates use the aerospace argument specifically to make space an Air Force mission. A new generation of space control advocates might lean toward a space force as do the high grounders, but the original control argument envisioned the Air Force as the space advocate.

Three of these four doctrinal schools collided during the 1981 Airpower Symposium on "The Role of the Air Force in Space"; this caused the various panels to reach kaleidoscopic conclusions because of the very diverse basic tenets of the doctrinal schools represented.(28) The sanctuary school either was not represented or remained silent because of the pugnacious attitudes displayed by the advocates of the opposing schools (doctrinal beliefs, either military or religious, are not taken lightly). Therefore, the sanctuary school's basic tenet that space surveillance systems make nuclear war less likely received very little consideration. The survivability school was well represented by individuals who questioned the survivability of each proposed system and submitted general schemes for space system survival. Control school advocates submitted several papers, most of which argued for a space doctrine based on either air power or sea power analogies. The most vociferous were the high-ground advocates, who presented numerous papers on space-based lasers and the new strategic opportunities available with space forces. Not all of the participants could be neatly classified as belonging to one of the schools (admittedly, the schools are neither as distinct nor as simple as they are represented to be in this chapter). Nevertheless, an organizational device like these space doctrines would have been very useful to those charged with summarizing the results of the symposium.

In a similar manner, the organization of current beliefs about the best way to employ space forces into doctrinal schools is useful for the purposes of this book. Starting with their basic tenets, we examine each of the schools in detail in chapters 4 through 7. As one might expect, there is substance in each of these strongly held beliefs, and their examination will lay the foundation for a space power doctrine presented in chapter 8, derived from the best elements of all four of these doctrinal schools.

NOTES

1. John F. H. Schenk, ed., *Proceedings of the Fifth Air University Airpower Symposium, 23-25 February 1981* (Maxwell AFB, Ala.: Airpower Research Institute, 1981), 2-12. (SECRET--Information extracted is unclassified.)
2. Participants at the United States Air Force Academy (USAFA) Symposium could not reach consensus on the question: "Does Doctrine Exist for Current Military Space Operations?" *Military Space Doctrine: The Great Frontier*, ed. Maj Paul Viotti, USAF, the final report from the USAFA Military Space Doctrine Symposium, 1-3 April 1981 (Colorado Springs, Colo.: USAFA, 1981), 80-81.
3. "Verbatim Report of Morrow Commission of Inquiry," *Army and Navy Journal*, 26 September 1925, 3-4, quoted in Robert Frank Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force 1907-1964* (Maxwell AFB, Ala.: Air University, 1974), 27.
4. Futrell, 22.
5. Several factors seem to have contributed to the sanctuary doctrine. First, there was President Eisenhower's hope that arms control could be accomplished through a worldwide "open skies" inspection and his desire to keep the arms race from expanding into space. Futrell, 277-79, 295-300. Second, proposed military space missions (other

than those dealing with earth observation or communication) appeared neither desirable nor feasible. George C. Spangler, "The Military Role in Space," *Bulletin of the Atomic Scientists*, June 1964, 31-34; Futrell, 429-36. Third, the Soviet development of nuclear weapons and missile delivery systems had, for the first time, seriously threatened US national survival. For a description of the "missile gap" and the role of space activities, see Philip J. Klass, *Secret Sentries in Space* (New York: Random House, 1971), 18-44. Finally, space systems have proved their worth as the national technical means of treaty verification. In 1980 Secretary of the Air Force Hans Mark argued that two space missions, strategic missile warning and surveillance, were "above all others that stand out as being of vital importance to national security." House, Committee on Science and Technology, *United States Civilian Space Policy*, H. Doc. 153, 96th Cong., 2d sess., 23-24 July 1980, 93-94.
6. The origins of the survivability doctrine are more difficult to trace. The doctrine may have developed from the general concern with survivability brought on by the nuclear age. In my opinion, it is an outgrowth of the sanctuary doctrine. Under the sanctuary doctrine, significant military capabilities were placed in space without any assurance that the Soviets would maintain the sanctuary. Therefore, the criticism of these capabilities was that they would not survive. This resulted in a focus on survivability. Brig Gen Donald A. Vogt verifies the existence of this belief structure in "Space Doctrine and Policy: Old Principles Are New Issues," *The Great Frontier*, 4 vols., a book of readings for the USAFA, Military Space Doctrine Symposium, 1-3 April 1981, comp. Peter A. Swan (Colorado Springs, Colo.: USAFA, June 1981), 4:882. Joseph E. Graetch claims that one tenet of the unwritten space doctrine is that "the dependency placed on space systems is constrained by their survivability." Joseph E. Graetch, "Doctrine with a Legacy," *The Great Frontier*, 2:292.
7. This school has several articulate disciples. For example, Lt Gen Daniel 0. Graham, USA Retired, *High Frontier: A New National Strategy* (Washington, D.C.: High Frontier, 1982), 1-13; Lt Col Dino A. Lorenzini, USAF, and Maj Charles L. Fox, USAF, "2001: A U.S. Space Force," *Naval War College Review*, March-April 1981, 48-67. Lt Col Barry Watts, USAF, and Maj Lance Lord, USAF, "Beyond the Missile Age--How to Think about Military Competition in Space" (Paper presented at the USAFA Military Space Doctrine Symposium).
8. From an address to the National Press Club on 29 November 1957. Quoted in Futrell, 280.
9. General White may be considered the founder of the control school. His views are summarized in Futrell, 279-82. Others have since assumed the cause. For example, see Lt Col Richard Earl Hansen, USAF, Retired, "Freedom of Passage on the High Seas of Space," *Strategic Review*, Fall 1977, 84-92.
10. Many of these arguments are presented in Carlo Trezza, "A New Dimension of Arms Control: Avoiding an Arms Race in Outer Space," *Trialogue*, Summer/Fall 1982, 46-51; and Hans A. Bethe and Kurt Gottfried, "Save Us All, Congress: No Weapons in Space, No Unratified Treaties," *Washington Post*, 6 February 1983, B1.
11. For an excellent summary of the survivability arguments, see Col Robert B. Giffen, *US Space System Survivability: Strategic Alternatives for the 1990s*, National Security Affairs Monograph Series 82-4 (Washington, D.C.: National Defense University Press, 1982), 33-34, 49-52.
12. Watts and Lord, 991.
13. Often both the sanctuary and survivability tenets are used to argue that ASATs should be banned. For example, Donald L. Hafner, "Averting a Brobdingnagian Skeet Shoot," *International Security*, Winter 80/81, 41-60; and Richard L. Garwin, Kurt Gottfried, and Donald L. Hafner, "Antisatellite Weapons," *Scientific American*, June 1984, 45-55.
14. As a measure of the impact of the sanctuary doctrine on military uses of space, Brig Gen Donald A. Vogt stated in 1981 that "employing space systems for military purposes is a difficult task that is still in the embryonic stage.... The problem at hand is to provide field commanders with an appreciation of the magnitude of the space capabilities that exist and how they will enhance mission effectiveness." Vogt, 882.
15. The civilian emphasis was extreme during the 1960s and early 1970s. For a discussion of some of the attempts to foster this civilian image and one view of the reasons for it, see Claude Witze, "How Our Space Policy Evolved," *Air Force Magazine*, April 1962, 86-92.
16. Klass, xiv-xv.
17. Giffen, 33-52. Based on the emphasis on "survivability" and the characteristics used to describe space forces, AFM 1-6 seems firmly planted in the survivability school. AFM 1-6, *Military Space Doctrine*, 15 October 1982, 5-6.
18. Graham, 195; Watts and Lord, 977, 1000-21.
19. Control school views seem to have almost vanished from the open literature by the mid-1960s, probably as a result of the sanctuary doctrine. Early advocates, most notably General White, did not detail the specific methods of achieving space control. These specifics were generalized by the author based on sea and air control concepts. However, control concepts have recently appeared in *USAF Fiscal Year 1984 Air Force Report to the 98th*

Congress of the United States of America, which talks in terms of denying the Soviets use of their space system and defending our systems (p. 38).
20. Dandridge M. Cole, *Strategic Areas in Space--The Panama Theory* (Los Angeles, Calif.: Institute of Aerospace Studies, 1961), 1-8.
21. See note 19.
22. AFM 1-1, *Functions/Basic Doctrine of the US Air Force*, 14 February 1979, 52.
23. House, *Report of Inquiry into Operations of the United States Air Service*, 68th Cong., 2d sess., 1925, House Report No. 1653, 291, as cited in Futrell, 26.
24. This doctrinal view was one, if not the major, force behind the establishment of the National Aeronautics and Space Administration. Futrell, 295-302.
25. In the late 1970s and early 1980s many, including the Secretary of the Air Force, advocated new organizational structures for space. The reluctance to make organizational changes seems to have been centered in the military side of the Headquarters USAF structure. It is not clear if this was due to the sanctuary beliefs or a reluctance by the Air Force to fund for space forces which would provide support to all the services. For a discussion of the need for organizational changes, see deputy assistant secretary of the Air Force for plans and policy, Dr Charles W. Cook, “Organization for the Space Force of the Future,” USAFA Military Space Doctrine Symposium, 467-99.
26. General White transferred the idea of centralized control from air forces to aerospace forces. Futrell, 281.
27. Lorenzini and Fox call for the establishment of a space force by 2001. Lorenzini and Fox, 62-64. The High Frontier Study criticizes the current structure for overlooking existing technology that could implement the high-ground doctrine. The study also calls for a US Space Force. Graham, 51.
28. The Airpower Symposium used a format in which four panels were convened at the same time. Depending on the papers presented, the individual panels often took on the flavor of one of the doctrinal schools. As a result, the chore of summarizing the entire symposium was extremely difficult. See the individual panel summaries in Schenk, *Proceedings of the Fifth Air University Airpower Symposium*.

CHAPTER 4

THE SANCTUARY DOCTRINE: A FALLEN STAR

Several recent events indicate that the sanctuary doctrine, the official doctrine since the Eisenhower Administration, is a fallen star. Two recent changes within the Air Force violated sanctuary beliefs. The event that received the most publicity was the establishment of the Space Command in September 1982.(1) Less visible but equally damaging to sanctuary beliefs was the publication one month later of a military space doctrine that emphasized space system survivability.(2) These two military actions could not have taken place without a change in national policy, and national policy was changing rapidly. President Ronald Reagan's announcement in March 1983 of a renewed emphasis on the development of technology for ballistic missile defense (BMD) was probably the strongest blow to the sanctuary school. The president did not specifically mention a space-based BMD system in his address, but his remarks were widely interpreted as a call for such a system.(3) Thus, in less than a year, military space doctrine seems to have temporarily resided in three of the doctrinal schools--sanctuary, survivability, and high ground--described in chapter 3.(4) It is not yet clear if the new doctrine is of the survivability, control, or high-ground school. One thing is clear--the sanctuary doctrine is passe.

Why examine a bygone doctrine? The sanctuary doctrine was developed and continuously reaffirmed by responsible, patriotic leaders in several administrations. Since it governed our space activities for almost 25 years, there most certainly was rationale for its existence. Furthermore, the sanctuary doctrine may not have any fatal flaw. To understand the doctrinal reformation, one must first understand the old doctrine and the reasons for its demise. Recall that doctrine was defined as what is believed to be the best way to employ forces. The sanctuary doctrine may be a “good” but not the “best” way to employ forces. In addition, the best is often in the mind of the beholder and a function of the times. As illustrated by President Reagan's BMD speech, military doctrines, particularly space doctrines, are strongly influenced by the policy of the administration in power. It is possible that a new administration may decide that the old doctrine is best and attempt to restore the space sanctuary. Thus, it is important to understand why the doctrine has changed and to recognize that sanctuary doctrine may someday return to favor.

In order to map the changes that may have made the sanctuary doctrine passe, we must start with an examination of the fundamental tenet described in chapter 3. That is, the basic tenet concerning the value of space forces. If this basic tenet withstands scrutiny, then we must examine the logic leading to the beliefs about the nature of space wars and employment of space forces. If the tenet is true and the logic sound, the sanctuary doctrine might be listed as one of the candidates for the best way to employ space forces.

The Basic Tenet of the Sanctuary Doctrine

The basic tenet of the sanctuary doctrine (space surveillance systems make nuclear wars less likely) is deeply embedded in the deterrent strategy. The deterrent strategy is, in turn, based on

the belief that meaningful defense against nuclear weapons is not possible (an assumption not accepted by the high-ground school). According to the deterrent strategy, the only defense against nuclear war is the threat of retaliation in kind.

To implement this strategy, the attacked nation must be able to absorb a first strike and still have sufficient capability to inflict unacceptable punishment on the enemy.(5) Space systems with their permissible overflight characteristic contribute to this strategy by observing the enemy's forces for treaty-monitoring and attack-warning purposes.(6)

The deterrent strategy is predicated on the assumption that neither side will permit the other to build enough weapon systems to make the first strike so massive that the other's retaliatory forces do not survive. Space systems support the deterrent strategy as the so-called national technical means of treaty verification.(7) A basic flaw in the deterrent strategy is that it naturally leads to continued arms buildups if there are no mechanisms for arms limitation agreements. As each side adds more offensive capability or enhances existing capability through technological improvement, the other is obliged to follow suit or see its retaliatory capability diminished. To keep the strategy from becoming an economic one where opponents try to build weapons until the other is bankrupt, a method to facilitate treaty limitations is required. Space systems have provided part of these “national technical means of verification.”

Space systems also contribute to the deterrent strategy by fulfilling the warning function. Based on the Triad concept, the United States helps maintain survivability of its retaliatory force by complicating the enemy's targeting problem. To prevent retaliation, the enemy must launch an attack that simultaneously negates US bombers, land-based missiles, and submarine-launched ballistic missiles (SLBMs). The Soviet submarine-launched ballistic missiles plus the ability of more powerful Soviet rockets to bypass ground-based warning systems by going into partial orbit posed a potential threat to the survivability of the US bombers in the late 1960s and early 1970s.(8) In addition, Soviet capabilities put at risk the US command and control system that was required to execute the retaliatory strike. Space systems largely countered this threat through their ability to see missiles being launched while the missiles were still over enemy territory and to provide global coverage of sea-based missile launch areas. In essence, space-based warning systems have become a fourth leg of the Triad.

In sum, an extremely good case can be made that space systems have exceptional value in reducing the likelihood of nuclear war under a deterrent strategy. However, the sanctuary school claims that the primary value of space systems is their contribution to the deterrence strategy--a claim disciples of the high-ground school reject. The high-ground school argues that the assured-destruction strategy should be replaced by an assured-survival strategy that would make the primary function of space forces that of shooting down the enemy's offensive forces. This viewpoint will be examined in chapter 7. It is sufficient to note here that the sanctuary and high-ground schools start with different fundamental beliefs about the nature of nuclear wars.

For the sake of discussion, this chapter assumes that the primary value of space forces is in accord with the sanctuary tenet. Under this assumption, we can assess the logic between the basic tenet and the sanctuary conclusion. That logic was presented in chapter 3 as follows. The primary value of space forces results from their ability to reduce the likelihood of catastrophic

nuclear war. Using space for military purposes other than the deterrent functions may cause wars in space. These wars may result in loss of the primary functions, with destabilizing effects. The risk of losing the primary functions cannot be worth the benefit gained. Therefore, space must be a sanctuary from military systems.

Disciples of the doctrine have not reached general agreement as to what constitutes a sanctuary, but they agree that development of weapons capable of satellite destruction would be a clear violation. Was the sanctuary dependent on a total absence of military systems, except for the counting, verification, and warning systems that formed the core of the doctrine? Should there be limitations on the uses of the data collected for these peaceful functions so as to give the systems no other than deterrent value?(9) These questions have never been completely resolved, but space wars cannot begin without space weapons. Therefore, the existence of an antisatellite (ASAT) system shook the whole doctrinal house of cards because it meant that the owner not only could violate the sanctuary but also had formulated some scenario under which he would do so. To the sanctuary school, ASATs signaled a loss of the space environment's physical and spiritual virginity.

Nevertheless, the space environment has maintained its deterrent value even though it has only been disguised as a virgin for most of the last 25 years. In the late 1960s, the United States developed an ASAT as a counter to the Soviet fractional orbital bombardment system (FOBS). Although their motive for doing so is not clear, the Soviets have also been testing ASATs since 1972.(10) Based on the existence of ASATs on both sides, it is clear that there is not a cause-and-effect relationship between ASATs and the loss of primary value, as argued by some sanctuary school advocates. In other words, nations commonly use weapons to achieve some political purpose and not just because they have them.

This definitional debate also reveals that the sanctuary doctrine, somewhere past its basic beliefs in the primary value of space forces, turns into a strategy. There are those in the sanctuary school who argue that the only way to maintain the deterrent value of space-based observation is to ban all space weapons, including ground-based ASATs. Others argue that "deterrent" and "military" functions can be separated and that treaties can be made which eliminate military functions from space. Still others contend that the nuclear powers have an equally important stake in the deterrent strategy and will accept mutual overflight for deterrent purposes, as the United States and the Soviet Union have done since the dawn of the space age.(11) Thus, the sanctuary will be maintained as long as offensive weapons directed at earth are banned from space. These various schemes to maintain the deterrent value of space forces are really strategies designed to maintain overflight rights.

The Doctrine as a Strategy

Because the sanctuary doctrine becomes a strategy somewhere between the basic tenet and the sanctuary conclusion, it should be analyzed as a strategy. That is, the objective is to maintain the same deterrent capabilities provided by space systems' characteristic of peaceful overflight. The plan for achieving the objective is to maintain space as a war-free sanctuary. The test of that plan is how it compares with other possible plans.

In their book *Introduction to Strategy*, Snow and Drew propose three principles that are used here to analyze the sanctuary strategy. The first principle is that strategies must link ends and means. In other words, would successful accomplishment of the plan produce the desired effect? Snow and Drew have found that the flaw in most strategies is that they are based on past objectives, not on present or future ones. Thus, the second principle is to continuously assess the currency of the strategy by reevaluating the objective and reassessing opportunity costs against benefits. The final principle is that strategies must consider reality and not illusions.(12)

The Linkage Test

The sanctuary strategy can be linked to national objectives through the encompassing deterrent strategy. National survival is unlikely in the event of a massive nuclear exchange; therefore, the only defense is to prevent or deter such a war. As previously mentioned, space systems support the deterrence strategy by fulfilling the counting, verification, and warning functions. A sufficient condition for space systems to accomplish these functions is for space to be a war-free zone. Therefore, there seems to be clear linkage between the sanctuary strategy and critical national objectives.

The Currency Test

The sanctuary strategy passes the linkage test, but has it somehow lost its currency? As previously mentioned, the deterrent value of space forces (their treaty monitoring and warning capabilities) has not decreased over the last decade but has actually increased as we have improved the technology for accomplishing those functions. Thus, if the sanctuary strategy has somehow become obsolete, it must be because of some lost opportunities inherent in making space a sanctuary. Could it be that technological advances have overcome the logistics handicap to such an extent that some of the offensive and defensive missions that were proposed in the early space age are now possible? Or has technology provided new space-based missions of more value than the deterrent capabilities?

The offensive and defensive opportunity costs of the deterrent strategy must be examined. The defensive system that is most often proposed for space basing is ballistic missile defense. Very few offensive systems have been proposed for the space environment. In fact an original impetus for the sanctuary doctrine was that space seemed to have little military value past the deterrent value described in the sanctuary tenet.

The Reality Test

Thus far the analysis has not answered the basic question--that is, why is the sanctuary doctrine passe? The sanctuary tenet seems valid, and precedent indicates that the superpowers seem to have accepted overflight for purposes related to the deterrent strategy. Admittedly, a pristine sanctuary may never be reestablished and, therefore, the idea that a sanctuary will guarantee deterrent value is naive. However, if there are no space-based defensive opportunities (excluding BMD), why is there a reason to build ASATs? The reason an ASAT capability is important is the impact of a space systems support on terrestrial military operations. Such a capability is becoming more important due to trends in military technology.

The first of these trends is that weapon systems continue to improve in range, accuracy, and destructive power. Ballistic missiles already have global ranges, almost pinpoint accuracies, and enormously destructive payload capabilities. The impact of this trend can be seen in the recent debate over MX basing. We may have reached the point where survivability of fixed assets cannot be assured using only passive means. Furthermore, the same trends are seen in air-breathing craft (airplanes and cruise missiles). Aircraft have possessed global ranges since the 1950s, and cruise missiles now have ranges measured in hundreds of miles.(13) Accuracies and firepower of systems carried by the air-breathing threat rival the ballistic missile.

The impact of these trends was felt by the world's navies as far back as 1967. During the 1967 Arab-Israeli War, the Egyptians sank the Israeli destroyer *Elat* with a Russian-built Styx missile fired from a patrol boat 12 miles away. In 1971, the Indians used the Styx missiles at similar ranges with good effect against the Pakistanis.(14) The trend continued with the Argentine use of the Exocet missile against the British during the Falklands War. Although these examples only involve short-range missiles fired at ranges close to a ship's visible horizon, it must be remembered these wars were between small powers using third-rate equipment. The Soviet and United States navies have over-the-horizon missiles with ranges many times those in the previously cited examples.

To be able to shoot over the horizon, one must be able to see over the horizon. While radar surveillance aircraft can see over the horizon and reconnaissance aircraft can bring data back from over the horizon, both have operational limitations. In the first place, aircraft observation has been around so long that navies have some very effective countermeasures. Second, the field of view of surveillance aircraft is limited by their line-of-sight vantage; getting close enough to see the target puts them in range of countermeasures. Third, the ranges of aircraft are not truly global without such capabilities as aerial refueling, as the British and the Argentines rediscovered in the Falklands War.

Space forces, using space-based radar, could overcome many of the disadvantages of aircraft as observational platforms. With their altitude advantages, their field of view would be greatly expanded. They could maintain at least periodic coverage without having to continuously burn fuel like the airplane. Finally, partly because of the sanctuary strategy, but mostly because of the technological difficulties in attacking them, space forces are almost invulnerable to the kind of timely, localized measures that have been developed against aircraft. Needless to say, space forces also have numerous shortfalls, such as the logistical limitations covered in chapter 3, that also limit their utility.

Advocating the value of spacecraft as a counter to the ability of ships to survive through mobility and stealth should not be taken to mean that space forces make navies obsolete. What it does mean is that if spacecraft are in sanctuary someone will be at a disadvantage in almost every tactical situation. Some may argue that if both sides have an equal ability to see, neither the offense nor the defense has an advantage. However, consider the differences between the US and Soviet navies. Under the sanctuary doctrine, the large US carrier battle groups--designed for power projection purposes--may be at a distinct disadvantage against a Soviet Navy armed with

the over-the-horizon assets specifically designed to counter US capabilities.(15) Why should space observation capabilities be in sanctuary when airborne or seaborne assets are not?

If space remains a sanctuary, the aforementioned weapon systems and observation trends, along with improvements in data processing, may negate the advantages of mobility for armies and air forces as well as for navies.(16) The capability of space systems to observe fixed and mobile targets anywhere on the earth is rapidly expanding. In fact, some experts argue that with today's technology, space-based radars could provide worldwide surveillance of surface ships as well as military and commercial aircraft.(17) In the not-so-distant future, the combination of space-based observational capabilities with advances in real-time data processing could allow real-time targeting of mobile targets that move much faster than ships. This future is much nearer than the one expected by the advocates of space-based lasers. In this near-term future, most mobile targets may become as vulnerable as today's fixed assets if space remains a sanctuary. Consider the impact of this trend on the proposed solution to the MX vulnerability quandary--the mobile ICBM (Midgetman).

If these current trends continue, the deterrent strategy may be undermined by its own component--the sanctuary strategy. If all fixed assets are already vulnerable and observation platforms in the space neutral zone place mobile forces at risk, a strategy which depends on being able to inflict unacceptable damage after absorbing a first strike would be clearly unsound. Although the sanctuary strategy is in support of a deterrent strategy today, it contains the seeds of its own destruction.

To this point, several of the flaws uncovered in the sanctuary strategy relate to Snow and Drew's third principle--the question of reality. First was the false assumption that overflight rights to support the deterrent value of space did not have the same value to both the superpowers and that advantage would be gained by denying overflight for peaceful (deterrent support) purposes. The second break with reality was the idea that opposing nations could accept the force-multiplication value of space-based observation platforms and its effect on the conduct of terrestrial wars and still allow space to remain a benign area.

A third break with reality is the illusion of an ideal sanctuary. It may be true that if space can be returned to an ideal sanctuary then its deterrent value is sustained. However, like lost virginity, the ideal sanctuary is irretrievable. According to many assessments, the Soviets have an operational ASAT that uses a variant of an operational ICBM as a first stage. What method of verification besides on-site inspection of all missile sites could ensure that the Soviet ASAT is limited or dismantled according to some treaty? The problem will become more acute as the US ASAT is tested because it uses an F-15 as a launch vehicle. Once the US ASAT is out of the bag, it will be most difficult to convince the Soviets that it has been put back in since, once the US ASAT is tested, any high performance aircraft must be considered a possible launching platform.

Furthermore, what requires that an ASAT be defined as a device that physically destroys the target? The Soviets have long claimed that the US space shuttle should be considered an ASAT.(18) Indeed, the shuttle could, within its limited range, pick up enemy satellites and bring them home. Using this reasoning, the Soviet manned spacecraft could also be used to disrupt US satellites. When the environment contained nothing but robots designed for simple peaceful

tasks, these hypothetical acts of mischief were not possible. Man takes the potential for mischief with him.

Advocates of the sanctuary strategy argue that the plan guarantees that the deterrent value of the environment will be maintained. The ideal has not existed since the 1960s, and the argument that an ideal sanctuary will guarantee the deterrent value of space is flawed by the assumption that the ideal is a possibility. Therefore, one cannot argue that the primary benefit of the sanctuary strategy over other possible plans is that it guarantees the deterrent value.

Notwithstanding all these illusions, the most critical flaw in the sanctuary strategy was the failure to recognize that any strategy is a two-actor art form in which the strategist must consider his own plan and the opponent's reaction.(19) While pursuing the sanctuary strategy, the United States has failed to consider the actions of the other actor, the Soviet Union. During the late 1960s, the Soviets made their first attempt to place weapons in space when they tested the fractional orbital bombardment system.(20) Although they eventually abandoned FOBS and supported the treaty banning weapons of mass destruction from space, it is not clear that this action was taken because of any space sanctuary doctrine. In fact, FOBS seemed to be discontinued because it provided little advantage when space warning systems became capable of seeing missile launches on a worldwide basis (the Soviet version of the LeMay doctrine). Moreover, after the United States scrapped the ASAT that was to counter FOBS in 1972, the Soviets continued testing their ASAT system. Today the only operational ASAT system belongs to the Soviet Union (the new US ASAT is still in development).

While their FOBSs and ASATs have violated the letter of the sanctuary strategy, Soviet integration of space assets into other warfighting capabilities have violated the spirit of the strategy. As previously mentioned, the United States took great pains to avoid the fact and appearance of military value in space systems. This was emphasized to such an extent that even today some US operational commanders are still in the dark as to the military utility of current space assets.(21) In contrast, the Russians have fully integrated space systems into their warfighting capabilities. Soviet space forces routinely play in Soviet military exercises and actually surged to support the Egyptians during the 1973 Arab-Israeli conflict.(22) While the United States has used space systems according to a one-actor sanctuary doctrine, the Soviets have deployed operational space forces.

The reasons for the sanctuary doctrine's demise are clear. It was developed by reasonable, peace-loving men who saw the deterrent value of the space systems in an era in which the awful nightmare of a nuclear war was no longer just a bad dream. It was an appropriate strategy for that time. As time passed, the space sanctuary strategy that was formulated from the doctrine to ensure deterrent value took on less meaning. The military value of space as an observational platform, the development of ASATs by both the United States and the Soviet Union, and irreversible trends in military technology all combined to make the strategy passe, Unfortunately, until recently the US leadership continued to view space through rose-colored glasses and mistook the Soviet acceptance of deterrent value for acceptance of our sanctuary plan.

The sanctuary doctrine is gone and cannot come back unless the military uses of space-derived observational data can be somehow controlled.(23) Nevertheless, whatever doctrine replaces it

must account for the valid sanctuary tenet, that space forces have incalculable deterrent value because of their "peaceful-overflight" characteristic. The new doctrine must retain this deterrent value or replace the deterrent strategy with a viable alternative.

NOTES

1. On 1 September 1982, the Air Force established the Space Command at Colorado Springs, Colorado. According to Under Secretary of the Air Force Edward C. Aldridge, the creation of a Space Command is recognition of the fact that space can no longer be viewed as "a nonhostile, benign environment." Leonard Famiglietti, "Benign Space Concept Ends with Creation of SPACECOM," *Air Force Times*, 12 July 1982, 23.
2. AFM 1-6, *Military Space Doctrine*, 15 October 1982.
3. "President's Speech on Military Spending and a New Defense," *New York Times*, 24 March 1983, A-20.
4. President Reagan's speech indicated that a high-ground doctrine is a goal. AFM 1-6 has a survivability school flavor. Other sources of Air Force policy suggest a control doctrine. For an example of the latter, see *Fiscal Year 1984 Air Force Report to the 98th Congress of the United States of America*, 1983, 37-38.
5. For a discussion of nuclear strategy, see Donald M. Snow and Dennis M. Drew *Introduction to Strategy* (Maxwell AFB, Ala.: Air Command and Staff College, 1982), 195-216.
6. Robert S. Cooper, director of the Defense Advanced Research Projects Agency (DARPA), has also described these capabilities of space forces: "Surveillance of terrestrial military activity, particularly from space, has had significant influence for peace in two major respects. First, space systems have been used to monitor military equipment development and production by both sides, with the aim of avoiding surprises and imbalances in the military capabilities of either. Second, space also has been used…to provide surveillance of current military actions and to warn of impending actions." Robert S. Cooper, "The Coming Revolution in Conventional Weapons," *Astronautics and Aeronautics*, October 1982, 73-75, 84.
7. Compliance with the Anti-Ballistic Missile Treaty, SALT I, and SALT II was to be assured by "national technical means of verification, including photo-reconnaissance satellites." *Arms Control and Disarmament Agreements* (Washington, D.C.: United States Arms Control and Disarmament Agency, 1982), 135, 243. For more details of the possible use of space assets for treaty verification see David Hafemeister, Joseph J. Romm, and Kosta Tsipis, "The Verification of Compliance with Arms-Control Agreements," *Scientific American*, March 1985, 39-45.
8. Francis X. Kane, "Anti-Satellite Systems and U.S. Options," *Strategic Review*, Winter 1982, 58.
9. Questions such as these are raised by Dr Eberhardt Rechtin, who concludes that the purpose of space wars will be to deny the enemy information from space and retain its use for one's own purposes. Eberhardt Rechtin, "Satellites and the Security of Nations," *Military Electronics/Countermeasures*, July 1981, 28-32.
10. For a background on both the US and Soviet ASAT efforts, see Marcia S. Smith*, Antisatellite (Killer Satellites)*, Issue Brief Number IB81123 (Washington, D.C.: Library of Congress, Congressional Research Service), 30 January 1982, 1-15.
11. Some argue that the Soviets accepted satellite overflight because the total secrecy policy had backfired during the early 1960s. US reactions to the bomber and missile "gaps" resulted in the production of Minuteman missiles and Polaris submarines in a very short time, a feat that took the Soviets at least 10 years to match. Philip J. Mass, *Secret Sentries in Space* (New York: Random House, 1971), 215-21.
12. Snow and Drew, 15-19.
13. For a comprehensive assessment of these trends and the impact on the US Navy, see Robert C. Powers, "Extended Horizon Command and Control in Naval Warfare," *Military Electronics/Countermeasures*, June 1981, pt. 1:34-41; July 1981, pt. 2:42-44; August 1981, pt. 3:71-75; and September 1981, pt. 4:64-66, 86.
14. Ibid., pt. 2:42.
15. Hodgen provides an excellent discussion of the US Navy's dependency on satellites and of the Soviet strategy that relies on satellites to counter our naval forces. Louise Hodgen, "Satellites at Sea: Space and Naval Warfare," *Naval War College Review*, July-August 1984, 31-45.
16. Cooper claims that the capabilities of space forces "Will render obsolete massed tactical forces." He sees the observational capabilities of space forces in combination with accurate over-the-horizon weapons as factors that deter tactical as well as nuclear warfare: "By the year 2000 deterrence of tactical warfare will likely be a reality.... Massed forces in warfare will become obsolete and regional warfare will largely be unknown." Cooper, 72-75, 84.
17. J. S. Aurin, "Space-Based Radar Prospects," *Military Electronics/Countermeasures*, September 1981, 28, 84-85, 91.

18. Kane, 60.
19. Snow and Drew, 7.
20. Robert S. McNamara, "Soviet Fractional Orbital Bombardment System*," Supplement to the Air Force Policy Letter for Commanders*, December 1967, 2-10.
21. Brig Gen Donald A. Vogt, USAF, "Space Doctrine and Policy: Old Principles Are New Issues*," Military Space Doctrine: The Great Frontier*, ed. Maj Paul Viotti, the final report from the US Air Force Academy Military Space Doctrine Symposium, 1-3 April 1981 (Colorado Springs, Colo.: USAFA, June 1981), 882.
22. Nicholas L. Johnson, "Soviet Satellite Reconnaissance Activities and Trends," *Air Force Magazine*, March 1981, 90-94.
23. The sanctuary school still has fervent disciples. See, for example, Thomas O'Toole, "Scientists Ask Ban on Space Weapons," *Washington Post*, 27 March 1983, 14.

CHAPTER 5

THE SURVIVABILITY DOCTRINE: A MISBEGOTTEN OFFSPRING

Before its passing, the sanctuary doctrine sired the survivability doctrine. Space assets deployed to support the deterrent strategy had considerable value for other military functions, but they also had severe military shortcomings. They did not satisfy military requirements for availability, reliability, supportability, and survivability.(1) They were short of these "ilities" for good reasons. Even though man had gone to the moon, space flight was still on the leading edge of technology and was a very costly endeavor. Furthermore, these assets were not designed to survive in a war zone but to function in a peaceful sanctuary.

Although most of these military shortfalls could be corrected or at the least endured, space system vulnerability (real or perceived) was a major constraint that could not be alleviated under the sanctuary doctrine. If space systems were depended on for warfighting capabilities, then the enemy would certainly attempt to deny those capabilities. The solution to this problem was to make the systems more survivable. This solution was frustrated by the sanctuary doctrine's premise that space should not have military value except to support the deterrent strategy, which did not require survivable assets. As a result of this dilemma, the belief was generated that space forces, by their very nature, were somehow more vulnerable than forces operating in the other environments.

The Survivability Arguments

This chapter analyzes the survivability doctrine using the same approach as in the last chapter. The main thrust is to examine the basic tenet--the survivability question. Based on the assumption that current or soon-to-be-developed ASATs will exploit the basic vulnerability, it looks at the capabilities of Soviet and US ASATs. The chapter identifies the space force characteristics, or combination thereof, that cause the vulnerability and examines the characteristics themselves in an attempt to uncover "inherent" vulnerability. The chapter also analyzes the retaliation-in-kind strategies supported by this doctrine.

The Conventional ASAT Threat

The only nation with an operational ASAT is the Soviet Union; therefore, an examination of the Soviet capability may uncover the reason for the inherent vulnerability of space forces. The Soviet ASAT is a ground-based system launched on an SS-9 rocket.(2) The SS-9 delivers an explosive warhead on a trajectory that intersects the target vehicle's orbital path. An extensive ground-based tracking network determines the target's orbital parameters and provides course guidance, and a radar or other sensor on the attacking vehicle provides final guidance to the target. The target vehicle is killed by shrapnel from the exploded warhead.(3)

The Soviet ASAT is simple in concept but does not offer much capability compared to the effort required. Although the SS-9 could propel massive payloads at global ranges as an ICBM, its range in its ASAT role is on the order of 600- to 1,000-nautical-miles altitude.(4) The system has only been tested against target vehicles whose orbital inclinations (angle between orbital plane

and the equator) fall in a very narrow band (possibly as limited as from 62 to 66 degrees). A 62-degree inclination is about optimum for the Tyuratam launch site, so the limitations observed in testing may indicate a similar operational limitation. The Soviet ASAT could be used against targets in broader inclination ranges, but at the expense of altitude capability.(5) Soviet test experience with this system against target vehicles whose orbital parameters are very well known has not been extremely impressive. The Soviets are batting 12 for 19 for the period 1968-82 and five for 10 during the period 1976-82.(6)

The Soviet ASAT system should not be taken lightly, because it does threaten US assets and presents a strategic asymmetry in space; but it certainly does not make all US space forces vulnerable. A considerable percentage of US space assets are at altitudes above 1,000 nautical miles and at inclination angles far outside those seen during the Soviet tests. Of the 18 US satellites launched between October 1978 and June 1979, only 6 could be threatened by the current Soviet capability.(7)

Furthermore, even if the Soviets deploy their ASATs in sufficient numbers to negate US forces that are within range, there are significant operational problems involved. As an example, the ASAT is launched or maneuvered into an orbit whose orbital plane coincides with the target's. It may take days or weeks before the target passes close enough to the launch site for a coplanar launch to occur.(8) Although orbital maneuvers could be used to achieve orbits coplanar with the target, the maneuver would cost altitude capability.

In sum, the present Soviet capability does not make US space assets more vulnerable than terrestrial-based assets. Based on the evidence, we would have to conclude that US terrestrial assets are more vulnerable to numerous threats (including terrorist acts) than are space systems threatened by the Soviet ASAT.

The conclusion that the inherent vulnerability of space systems is a myth is often countered with the rather boastful argument that if it were not for sanctuary doctrine constraints, the United States long ago would have exploited space-force vulnerability with an ASAT more capable than the Soviets'.(9) An examination of the proposed US system does not support this assertion. The US ASAT now under development is similar to that of the Soviets except that the first stage of the launch vehicle is an F- 15 aircraft, and the kill mechanism is different. The aircraft fires a small rocket armed with a device termed the “miniature homing vehicle.” This small vehicle uses an infrared sensor to track the target. As with the Soviet system, precise knowledge of the target's orbital parameters is required for the F-15 to get the homing vehicle in the general vicinity. The miniature homing vehicle rams the target for a hypervelocity kill.(10)

The US ASAT will have constraints similar to the Soviet version. It will also be limited to low altitudes. It will not, however, have as severe restrictions on target orbital geometry. Because the launch site can be any friendly airfield that can accommodate an F-15, the system should be able to attack targets within greater ranges of inclination angles and under less-severe timing constraints than the Soviet system. Rather than waiting for the target to move over the launch site, the F-15 provides a mobile launch site that can be moved under the satellite.(11) In addition, because an aircraft launch is more difficult to detect, countermeasures based on launch detection would be more difficult to employ. Although the US system appears somewhat more capable on

paper, we must emphasize that it is only a paper tiger which is not expected to be operational until 1988.(12) Both the Soviet and the US ASATs, when they become operational, will threaten only low-flying spacecraft.

The long lead time required for the development of both the Soviet and the US ASATs counters one of the other myths that has surrounded space forces since Sputnik: that very effective ASATs can be developed in very short times using cheap off-the-shelf components. Both the Soviet and US systems use or will use existing launch vehicles; nevertheless, both systems have been or will be under development for over 10 years. In addition, ASAT development does not appear to be the cheap undertaking that one would expect from using off-the-shelf components. It seems that those who thought ASAT development would be easy forgot the Clausewitzian adage that “everything in war is very simple but the simplest thing is difficult.”(13)

Another popular myth is that all it takes to increase the altitude capability of current ASATs is to boost the current warheads with bigger rockets. This argument ignores the current limitations on space-tracking capabilities to see and therefore to provide target information at the higher altitudes. Radar is the mainstay of current space track networks; but radar observation is limited by altitude, and current systems cannot see to geostationary altitudes. Optical systems which can see farther have operational limitations due to weather and the time required to reduce the data. In addition, space-tracking coverage depends on the number and dispersion of space track assets, which are limited by the extent of a nation's territorial control and occupancy of overseas bases.(14) Finally, the increase in rocket size to get to common high-altitude cluster points is not linear. That is, the most common high-altitude orbits are either polar (sun-synchronous) or equatorial (geostationary), which are orbital inclinations difficult to reach. Thus, to scale up current ASATs to higher altitudes, the space powers will have to make a tremendous investment in tracking capabilities and rockets with the necessary thrust.

The Nuclear Threat

Those who believe that current ASATs make space forces vulnerable argue that the nuclear threat in space also must be considered. The argument is presented as follows. Both the United States and the USSR (and several other nations) have the capability to deliver a payload to a given orbit. That payload can just as easily be a nuclear weapon as a weather satellite. If the payload is a nuclear weapon with a large kill radius, sophisticated terminal guidance systems would not be required. All that would be required above the basic delivery capability is the ability to fuze the weapon to explode at the proper time (not as simple as it seems if the target and the interceptor are moving at such tremendous relative velocities). In fact, the debate over the success rate of the Soviet ASAT tests is based on the argument that most of the tests could be considered successes if a nuclear rather than a conventional warhead is assumed.

The proponents of the nuclear space threat further argue that the political insensitivity of the environment makes the use of nuclear weapons more likely in space than in the terrestrial environments. Few, if any, people would be killed, and a nuclear weapon in space would cause none of the environmental damage caused by terrestrial explosions.

Based on the long-range kill mechanisms of nuclear weapons in space and the political arguments presented earlier, the nuclear threat in space is often blown out of proportion. Those who believe in the survivability doctrine often express the vulnerability in terms of “one nuclear explosion in space and all of the satellites will cease to function.”(15)

Numbers revealing nuclear kill ranges versus satellite hardness are not available in open sources, but the following example gives some idea about the range of nuclear weapons in space. Suppose a one-megaton (the energy equivalent of two billion pounds of TNT) nuclear weapon is exploded in space and all the energy is converted into electromagnetic energy (gamma rays, X rays, etc.). This energy travels outward in all directions so that at some distance--for instance, 100 nautical miles--from the explosion, the energy passes through a sphere with a radius of 100 nautical miles (608,000 feet). The amount of energy that passes through a square foot of the sphere is equal to the energy equivalent of .00000431 pounds of TNT. In other words, the energy that would impact a satellite with a one-square-foot cross-sectional area at a distance of 100 nautical miles from the explosion would be a very small fraction (.00000431 pounds) of the original two billion pounds. For comparison, the amount of the sun's energy per second that would be encountered by the same size satellite (in near-earth orbit) would be equivalent to. 00819 pounds of TNT.(16)

Of course, there are nuclear weapons bigger than one megaton; the energy of the bomb arrives instantaneously while the energy from the sun is spread out over a second; and the sun's energy contains less of the high-energy radiations that may do the most damage to the satellite. However, one should also keep a sense of proportion about distances in the space environment. For example, the geostationary orbits are at an altitude of about 22,000 miles; therefore, two geostationary satellites on opposite sides of the earth are 45,000 nautical miles apart. Geostationary satellites one degree apart are about 400 nautical miles apart. Furthermore, military communications satellites in geostationary orbits usually maintain a position accuracy of plus or minus one degree, so they can be anywhere in an 800-nautical-mile strip of the geostationary zone.(17) Because of the distances involved and the dilution of energy with distance, one nuclear weapon would not be lethal to many satellites even in the cluster points, and even nuclear weapons would require more than “Kentucky windage” guidance systems. Finally, recent tests have shown that hardening techniques used in military satellites against direct nuclear radiations are effective.(18)

In addition to the direct radiations produced by nuclear weapons, there are delayed effects that must be considered. The ARGUS nuclear tests conducted by the United States in 1958 showed that bomb debris and electrons resulting from fission product decay were trapped in the earth's magnetic field, creating an artificial Van Allen belt. In the STARFISH test conducted in 1962, seven satellites were damaged by electrons that had been trapped within the earth's magnetic field. Although none of these satellites were in line of sight of the explosion and, therefore, none received direct radiation, over periods of several months the trapped electrons damaged solar cells and other electrical components, which caused satellite failures. These delayed effects are limited to low altitude and are very similar to those resulting naturally from the Van Allen belts. Thus, only low-altitude satellites are threatened by these delayed effects and most such satellites have been provided some hardening against these effects since the discovery of the Van Allen belts.(19)

Even though their lethality is often overstated, the nuclear ASAT are not surgically precise weapons; therefore collateral damage would have to be considered. The nation that initiated the attack would have to avoid destroying its own space assets, which might mean that certain enemy targets near friendly assets could not be struck. First use of nuclear weapons would also be complicated by a lack of knowledge of the exact lethality of the weapons because there has been very limited nuclear testing in space.(20) Not only would the nation initiating the attack have to avoid its own assets, it might miscalculate the hardness of its own vehicles in comparison to the enemy's and thus destroy its own capabilities by mistake. Additionally, in an environment where military and civilian satellites coexist in close proximity, the use of nuclear weapons might do extensive collateral damage to civilian assets. Such collateral damage will be a severe problem as the hardening differential between military and civilian satellites becomes more pronounced.

Nor can a nation planning to use nuclear weapons in space ignore the political and military consequences of their use. Although there are few nations with launch capabilities, almost every nation in the world relies on space systems for extremely important functions. The loss of weather, communications, and land resource satellites would have enormous effect on many countries.(21) In addition, unless the nuclear genie has been released during a global war, the aggressor would have to worry about the effects of inadvertently destroying the other nation's assets that support the deterrent strategy. For example, a show of force intended to destroy a satellite broadcasting propaganda might cause a global nuclear war if the attack inadvertently destroyed the opponent's ballistic missile attack warning system.

Although the consequences of nuclear weapon use in space cannot be compared to their use on earth, they have serious limitations as space weapons. Nuclear weapons have a large kill radius, but the environment is enormous and the targets are spread so widely as to nullify that factor (an individual weapon would be required for most targets). Even though few people may be killed, the political and military consequences of using nuclear weapons in space may be severe. The environmental damage may be considerable and may have long-term effects on friend and foe alike. Partially for these reasons and the fact that there are treaties banning nuclear testing and nuclear weapons in space, both the United States and the USSR have developed ASATs based on conventional rather than nuclear weapons.

Future Threats in Space

Opponents of the view that the vulnerability of spacecraft has been greatly exaggerated will argue, with some justification, that today's vulnerability or the vulnerability that will exist in the near future is not the correct issue because we must take a longer view of the threat to space forces. The basis for this argument stems from the logistical constraints on space-force characteristics that were detailed in chapter 2. Because of the difficulty in getting to the environment and the lack of access to much of the medium, US space vehicles have been designed to last for a decade. Therefore, spacecraft launched today must be designed to survive the threats possible in the 1990s.

The usual approach to future threat analysis is to hypothesize offensive systems that may cause future vulnerabilities, but this approach has several pitfalls for the purposes of this chapter. The basic tenet of the survivability school is that space forces are *more* vulnerable than forces in other environments. Showing that a given space system has vulnerabilities does not prove this contention. What must be proved is that there is some inherent characteristic that makes space forces more vulnerable. Therefore, rather than examining future threats, it is more appropriate to look for the basic flaw in space systems. A second pitfall is that the study of history seems to indicate that for every new offensive weapon, a defensive counter will eventually develop. Thus, by proposing new offensive threats, one starts an endless loop, because the defensive counter to each new offensive capability also should be examined. These offense-versus-defense discussions are not often fruitful because the argument degenerates to the question of which technology will be ready first. Finally, space forces have too often been shot down by paper systems that were not held to any feasibility, affordability, or believability criteria.(22) Based on these pitfalls with the normal approach, the approach to the future threat in this chapter is to look for the space force characteristic or the combination of characteristics that cause the vulnerability.

Vulnerability of Quasi-Positional Forces

The quasi-positional characteristic of space forces distinguishes them from air, ground, and sea forces and therefore might be a contributor to their alleged inherent vulnerability. To explore this possibility, we should look at military assets from a targeteer's point of view. Terrestrial targets can be divided into two categories--fixed and maneuvering. A ballistic missile silo exemplifies the first category, an aircraft in flight the second. Obviously the same entity may at times belong to both categories. For example, an aircraft parked on the ramp is fixed but becomes a maneuvering target on takeoff. However, from the targeteer's point of view, the capability to maneuver is the important consideration. Therefore, the airplane sitting on the runway must be considered a potential maneuvering target.

Space forces do not fit well into either of these two categories, so the space force targeting problem must be viewed from a different perspective. This new perspective involves dividing a spacecraft's motion into three components. The first of these is its predictable path through the heavens. This predictable motion can be calculated (according to Newton's laws) based on the ideal gravitational attraction between the spacecraft and the body it is orbiting. If these ideal gravitational forces were the only forces causing a spacecraft's movement, the motion would be as predictable as that of a railroad train that maintained a perfect timetable. Unpredictable motion, or at least less predictable motion, results from forces on the spacecraft that are difficult to model. For example, the gravitational attraction of the earth is less than ideal and cannot be quantified perfectly because of the earth's nonhomogeneous mass and “pear” shape. In addition, the gravitational effects on the space vehicle's motion due to the other bodies in the solar system are difficult to quantify. Atmospheric drag effects extend far into space and cannot be defined precisely because they vary with the sunspot cycle, the time of day, and the shape of the vehicle. These unquantifiable forces cause unpredictable motion which requires that new observations of the spacecraft's position be taken periodically so that it does not become too far “lost.”(23) For example, a three-day prediction may be able to locate a satellite (in an ideal orbit for prediction purposes) within .62 miles of its actual position; the error increases with time.(24)

The final type of motion associated with space forces is maneuverability, or motion directed by intelligent choice for a specific purpose. As mentioned in chapter 3, the capability to maneuver is limited by mission constraints and current technology, but these constraints are not as binding as those that make a missile silo a fixed asset. Therefore, technology permitting, all space forces could maneuver based on a decision to trade some current mission capability for survivability.

The difference between space forces whose maneuverability is limited by mission constraints (“fixed” space forces) and fixed terrestrial forces is the unpredictable motion. Because of this motion, these “fixed” space forces cannot be targeted as easily as fixed terrestrial targets because their positions must be periodically monitored by an extensive tracking system.

Thus, from the targeteer's perspective the quasi-positional space vehicle is more difficult to deal with than fixed terrestrial assets. In addition, because there are no physical limitations on maneuverability, only technological and mission constraints, space forces present the same difficulties to the targeteer as do maneuvering air forces. In sum, there seems to be no inherent vulnerability in the quasi-positional nature of space forces.

Although the quasi-positional nature of space forces seems to make them less vulnerable than fixed terrestrial assets, this characteristic in combination with the vehicular sovereignty characteristic has been proposed as the reason for the inherent vulnerability. The proposal usually takes the form of a space mine deployed according to the following scenario. One nation “plants” the mine near a potential enemy's assets so that both vehicles pass through space as fellow travelers. At the war's start, the mine is exploded, destroying the enemy's assets.(25)

The space mine scenario is too simple. In the first place, because the mine and the target are moving together, the relative velocity between the two will be zero and the hypervelocity kill mechanism cannot be used. The explosive charge in the mine must provide the impetus for the shrapnel kill. Although nuclear devices could be used, they would present many of the same problems discussed earlier. Because conventional explosives would be range limited, the mine must remain in close proximity to the target, which would require the mine to be a more complex device than proponents like to admit.

Some of this complexity results from what has been previously described as unpredictable motion. Much of this unpredictability is the result of differences in vehicle size, shape, and composition. Movement caused by atmospheric drag or lift will depend on the aerodynamic shape of the vehicle. The thrust caused by solar pressure is dependent on the surface area toward the sun. Vehicle outgassing (the boiling off of vehicle matter in the space vacuum, which produces thrust) is dependent on the type of material used in the spacecraft's construction. Two spacecraft may start as fellow travelers but will drift apart because of this vehicle-dependent unpredictable motion. The differential in drift rates means the space mine must have the sensor systems to track the target vehicle or be fed updates from other friendly sensors. In addition, the mine must have the propulsive capability to make the necessary adjustments so that the vehicles “drift” together. The mine would also need sufficient propulsive power to follow the target as the target is moved for station-keeping purposes or to some less preferential orbit to perform its mission.

Furthermore, it would seem the combination of quasi-positional motion and vehicular sovereignty is not too distinct from the characteristics of naval ships. Surface naval forces do not appear to be unduly threatened by simple surface vehicles designed to self-destruct when the war starts. In fact, naval experience indicates that similar threats (e.g., the naval mine and the torpedo boat) were overcome by fairly straightforward changes in tactics and by countermeasures such as mine sweepers and screening destroyers.(26) It is not too difficult to imagine a "screening destroyer" placed between the space battle station and the mine to intercept either the shrapnel or the nuclear energy.

Logistical Vulnerabilities

Another proposed candidate for the space force "inherent" vulnerability flaw is the set of logistically influenced characteristics. The premise is that the vulnerability is not caused by the possibility of physical destruction but by the difficulty in replacing or repairing damaged assets. Space-launch capabilities are extremely vulnerable because of their size and, in the United States, their proximity to international waters. Spacecraft spares are not usually available; even if they were, they might take months to get into orbit. In sum, unlike terrestrial forces, space forces lost in battle would be lost for the duration.

This argument suffers from several faults. First it implies that terrestrial forces lost in some major conflict would be replaceable. If one assumes that Cape Canaveral is going to come under attack, then one also should assume that aircraft factories, shipyards, and tank factories will be attacked. Under the deterrence doctrine, the United States has not attempted to make any of its production facilities for military equipment survivable. Thus, the assumption that space forces are more irreplaceable than terrestrial war assets is faulty.

The second flaw in this argument is that it assumes that the current space force deployment strategies are the result of some inherent limitation rather than rational choice. Only recently have US space systems had any sustainability requirements. Under the sanctuary doctrine, space forces were designed only to survive until the war's start even if the first shots were directed at the space systems. The Soviets have not neglected sustainability considerations and have demonstrated a capability for rapid replacement of certain of their space forces. Techniques other than rapid replacement launches might be more effective. For example, on-orbit spares hidden in the infinite expanse of space would require no reliance on vulnerable launch facilities. Thus, the space force logistical handicap can be ameliorated under other than a sanctuary or survivability doctrine.

Concentration Vulnerability

One could go through all the rest of the space-force characteristics looking for a fatal flaw; however, further pursuit of this approach may be unproductive. Even though it can be argued that none of the space force characteristics cause a fatal survivability flaw, some people profess an intuitive feeling that a communications system based on satellites is just somehow more vulnerable than the old network of high-frequency radio stations and submarine cables that they replaced.

This intuitive feeling of vulnerability stems from the global coverage characteristic of space forces. Actually, the reason is the obverse side of that characteristic where once widely dispersed functions are now concentrated in one space vehicle. Or, said another way, one space vehicle becomes a set of eyes and ears that can replace a large number of ground-based facilities. As examples, weather, communications, and navigation satellites can respectively replace many weather stations, ground-based communications facilities, and inertial navigation systems in airplanes. Whereas simultaneous physical destruction of these dispersed capabilities would be extremely difficult, if not impossible, the replacement space system produces a chokepoint--the satellite. Although the satellites may be more difficult to destroy than any of the individual assets they replaced, the space segment is a vulnerable concentration point.

Several considerations must be kept in mind about this concentration vulnerability. First, space forces did not just replace terrestrial assets; rather, they provided much more capability. For example, global collection of weather data was not practicable before the advent of the weather satellite. Before the space age, military forces could not expect to go anywhere on the globe and be supported with weather reports. Nor were communications really global before the space age. The navigational capabilities from satellite-derived data will be superior to that available from human navigators and all but the most expensive inertial navigation system.(27) Therefore, while one might argue that the "old way" was less vulnerable, the old way did not provide the same worldwide capability.

Second, it is not clear that the survivability of widely dispersed ground-based weather, communications, and surveillance capabilities is superior to that of space assets in every situation. In order to cut the flow of data from these dispersed networks, only critical nodes rather than the entire network have to be destroyed. In addition, destruction of those parts of the network close to the battle zone usually suffices to stem the flow of critical information. In World War II, the Allies maintained an advantage in forecasting the weather over the Normandy beaches by destroying German weather stations in the North Sea.(28) Numerous examples could also be cited where loss of a single communication node or terrestrial surveillance asset resulted in catastrophic loss of critical information. In many situations, the "inherent survivability" of space assets resulting from the level of effort required to reach the environment may provide better survivability than can be afforded to vulnerable nodes of dispersed terrestrial systems.

Furthermore, the concentration vulnerability is not a problem with all space force missions. Ballistic missile warning systems require substantially the same number of surveillance satellites for support as they would ground-based radars (although the satellites provide better coverage). Therefore, the number of weapons required to attack the space warning assets in comparison to those on the ground is substantially the same, with the ground assets being more vulnerable from a level-of-effort standpoint. In addition, certain functions of space forces, such as worldwide surveillance, cannot be accomplished by terrestrial assets. Therefore, it is incorrect to conclude that the "concentration vulnerability" is a characteristic of all space forces.

Aside from the concentration vulnerability of some space forces in some situations, there seems to be no substance to the survivability doctrine's basic tenet that space forces are inherently vulnerable. Based on the foregoing discussion, we can conclude that space forces have a unique

set of military characteristics but are neither more nor less vulnerable than military forces in the other environments.

Although based on false premises, the survivability doctrine has influenced US space strategy by fostering the development of ASAT weapons suitable only for a retaliation in kind or a space denial strategy. These two strategies are clearly not in the best interest of the United States, which can be shown after a brief review of the employment characteristics of the terrestrial-based ASAT.

Strategies Fostered by Current Antisatellite Systems

Since neither the Soviet nor US ASATs can be used to defend space assets, they must be considered offensive weapons. The Soviet ASAT is a co-orbital device; that is, it is launched into an orbit that intersects the orbit of the targeted vehicle at the proper time and makes the kill before completing two revolutions. Because it resides in space for such a short time, the Soviet ASAT will not be vulnerable to a US ASAT.(29) It normally takes several revolutions for a ground-based space-tracking network to obtain enough information to be able to provide accurate predictions of a spacecraft's orbital parameters. In addition, during the Soviet ASAT's short flight, it may never pass over locations from which the F-15 can be launched. Similarly, the Soviet ASAT is not effective against the US ASAT, a miniature vehicle that never really goes into orbit but follows a direct ascent trajectory much like that of a short-range ballistic missile. Therefore, even if the Soviet space-tracking system could detect a miniature vehicle launch, an ASAT would have no value against this nonsatellite. Thus, both the US and Soviet ASATs can kill satellites but not each other and are therefore offensive (space-denial) rather than defensive weapons.

A doctrine founded on the belief of the inherent vulnerability of space forces and based exclusively on denial weapons results in two possible strategies, neither of them in the best interest of the United States. One is the retaliation-in-kind strategy envisioned by the survivability school adherents. This strategy is based on the idea that a retaliation capability will deter the enemy from initiating hostile action in the first place. A second strategy based on denial weapons would be appropriate when it is to one's advantage to negate the enemy's use of a medium. In a denial strategy, one is not interested in controlling the medium--denying its use to the enemy and defending friendly use--only in denying its use to the enemy. One of these two strategies must be appropriate if the United States is to depend exclusively on space denial weapons.

Retaliation-in-Kind Strategy

A retaliation-in-kind strategy is appropriate when the consequences of using certain weapons are so catastrophic that nobody wins the war, or when the possible use of the same weapons by both sides negates any advantage in using them. Nuclear weapons (at least in the American view) are examples of the former. In an all-out nuclear exchange, such devastation would occur that neither side could hope to survive with its societal institutions intact. Therefore, there could be no rational reason for either side to start such a war. Chemical weapons seem to fit in the second category. They are not very good weapons because, depending on weather conditions, they may

affect both friend and foe. The advantage of chemical weapons seems to occur when one opponent can threaten use and the other cannot. If both sides have to fight while constrained by such protective devices as the current chemical suits, neither has an advantage. Biological weapons might fit into both categories. If one side starts plagues against which the other is defenseless, neither might gain any advantage and there might be catastrophic effects on all of mankind.

As previously mentioned, the survivability school had its roots in the sanctuary school, which believed that the use of weapons in space would be catastrophic. The sanctuary school saw wars in space as all-or-nothing affairs. That is, if one satellite were shot down, then all overflight rights would be denied, and this would have devastating effects on the nuclear deterrent strategy. The two flaws in this argument are that it overlooks the stake that both sides have in deterrence and it assumes that all space assets have equal strategic value. It assumes, for example, that if the Russians shot down a US direct-broadcast satellite (which they have threatened to do if we launch one) or a tactical communications satellite, we would retaliate by shooting at everything in space, including their strategic warning systems, and the space war would continue until neither side had space assets.(30) This belief in catastrophic space wars runs counter to our experience in the other environments where limited wars are fought for limited political objectives.

If space wars are not necessarily catastrophic, is the retaliation-in-kind strategy beneficial because it removes the advantage of employing ASATs since both sides have them? If neither side employs ASATs because the other has them, the space environment would be in sanctuary. This “armed sanctuary” would have the peaceful sanctuary's shortcomings that were described in chapter 4. In addition, it would provide the Soviets (and the United States) the opportunity to violate the sanctuary at will. If the peaceful sanctuary strategy was not appropriate for the United States, a retaliation-in-kind strategy that gives the enemy the first punch is certainly inappropriate.

Denial Strategy

If a retaliation-in-kind strategy is not in our best interest, perhaps a space-denial strategy meets our objectives, because the environment gives the Soviet Union such an advantage that we only wish to deny Soviet use. For example, would it benefit the United States to use a space strategy like the German U-boat strategy in World War II? The use of the sea lines of communication was much more important to Britain and its Allies than to the Germans. Also the Allies had better capabilities to control the Atlantic Ocean. Thus, the Germans used what was essentially a denial weapon, the submarine, in a denial strategy. Are there similar scenarios that dictate a US space-denial strategy? An examination of some likely war scenarios will provide an answer to this question.

It is difficult to envision the value of a US space-denial strategy in a nuclear war scenario. Based on the nuclear deterrent strategy, the United States has assumed a defensive posture and has disclaimed any intention of a first strike. It is not clear how the United States could initiate a space-denial strategy using ground-based ASATs (after receiving a devastating nuclear strike). The value of such a strategy after the Soviets had preempted is also questionable. If such a

strategy seems unworkable in a global nuclear war, it also seems inappropriate in a limited nuclear war. Those who believe in the possibility of this type of nuclear exchange think that to control escalation both sides would refrain from striking at the other's tactical warning and attack assessment systems. One could also make a case that communication system and nonwarning surveillance systems would be spared. In other words, space-based eyes would not be attacked or the war might escalate. Therefore, it is difficult to fit a space-denial strategy into either a global or limited nuclear war scenario, at least from the American perspective.

At the conventional war level, a US space-denial strategy also seems unreasonable unless it is part of a control strategy. As pointed out in chapter 4, one cause of the sanctuary doctrine's downfall was the value of space forces in affecting the outcome of terrestrial wars. The most likely conventional war scenarios between the United States and the USSR take place on the periphery of the Soviet Union. In these scenarios the United States has a geographical disadvantage which would make the global presence capabilities of space forces extremely valuable for weather reconnaissance, surveillance, communication, and navigation. The Soviet Union could substitute other capabilities to accomplish many of these space missions or even do without some capabilities (weather and navigation) due to its proximity to the battle zone. Hence, if both the United States and Soviet Union adopted a denial strategy, the United States would be at a distinct disadvantage. Therefore, a control rather than a denial strategy would be more appropriate in a conventional war strategy.

In sum, the survivability doctrine has little to offer. It is built on the false tenet that space forces are inherently vulnerable. The doctrine fosters a belief in retaliation-in-kind space wars which is based on the sanctuary school's incorrect assumption that space wars would be total wars in that environment. Finally, reliance on ground-based ASATs supports only a denial strategy that appears to have little value without the other half of the control doctrine--the capability to defend space assets. The survivability school will be very detrimental if it prompts us to depend on passive survivability measures to the exclusion of active defense. If this mistake is not made, the survivability school, in the final analysis, may have been very beneficial because it fostered thinking about ways of preserving our military space assets and therefore partially extracted us from the defunct sanctuary school mentality.

NOTES

1. Lt Gen Richard C. Henry, USAF, “The Role of the Air Force in Space,” an unclassified plenary address presented at the Fifth Air University Airpower Symposium, *Proceedings of the Fifth Air University Airpower Symposium* 23-25 *February 1981*, ed. John F. H. Schenk (Maxwell AFB, Ala.: Airpower Research Institute, 1981), 172-78. (SECRET--Information extracted is unclassified.)
2. For an excellent summary of the SS-9 in all its launch roles, see Phillip S. Clark, “The Scarp Programme,” *Spaceflight*, 5 May 1981, 147-52.
3. The technical details of the pre-1977 Soviet ASAT testing are very well covered in G. E. Perry, “Russian Hunter-Killer Satellite Experiments,” *The Royal Air Force Quarterly*, Winter 1977, 328-55. Summaries of both the US and Soviet ASATs can be found in the following two documents: Marcia S. Smith, *Antisatellite (Killer Satellites)*, Issue Brief Number IB81123 (Washington, D.C.: Library of Congress, Congressional Research Service Major Issue System), 30 June 1982, 1-15; and Craig Covault, “Antisatellite Weapon Design Advances*,” Aviation Week and Space Technology*, 16 June 1980, 243-47.
4. Covault, 244.

5. Launch geometry affects how efficiently a missile can achieve an orbit with a given inclination. One constraint is the latitude of the launch site. Without performing expensive thrust-robbing maneuvers (termed doglegs) in the atmosphere or orbital transfers once in space, an orbital inclination angle less than the latitude of the launch site is not possible. For example, the minimum orbital inclination achievable from a Tyuratam (latitude 45 degrees) launch site without the above mentioned maneuvers is 45 degrees. The Soviet ASAT is launched from Tyuratam and so loses some range capability if it is launched into orbits with inclinations less than 45 degrees. Because of the earth' s rotational velocity, the achievable altitude is dependent on the azimuth of launch. Eastward launches benefit most from the earth's rotation, there is no benefit to northern azimuths, and westerly launches have to overcome the earth's rotational velocity. Therefore, the more northerly launches from Tyuratam achieve high-inclination angles at the cost of payload. J. Fredrick White, ed*., Flight Performance Handbook for Powered Flight Operations* (Redondo Beach, Calif.: Space Technology Laboratory Inc., 1962), 3-1 to 3-4.
6. The 12-for-19 success rate is given in Paul Stares, "Outer Space: Arms or Arms Control," *Arms Control Today*, July-August 1981, 1-8. The questions concerning the number of Soviet tests and the criteria for measuring test success are discussed in Smith, 3-4.
7. Statistics based on the launches listed in "Satellite Digests 122-132," published as a regular feature in *Spaceflight*, January through December 1978. The number of US satellites deemed vulnerable to the Soviet ASAT was based on perigee altitude and inclination angle.
8. Perry, 328-35.
9. The General Accounting Office observed that the F-15-based ASAT started out as a cheap and quick way of protecting American assets but is quickly becoming a complex, expensive one. Leonard Famiglietti, "GAO: ASAT Cost Soaring to 'Tens of Billions,'" *Air Force Times*, 28 February 1983, 23.
10. Smith, 1-15.
11. Covault, 245-47.
12. Famiglietti, 23.
13. Carl von Clausewitz*, On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ.: Princeton University Press, 1976), 119.
14. "Space Surveillance Deemed Inadequate," *Aviation Week and Space Technology*, 16 June 1980, 249-54, 259.
15. In a question-and-answer session in the Air War College during which an Air Force general officer was discussing operational problems in his command, a student suggested that space forces might provide the solutions. The general replied, "Those overhead systems are not survivable; one nuclear detonation in space and they all go away."
16. The solar constant is the radiation energy intercepted each second by a unit area in space the same distance from the sun as the earth. The value of the constant is 1.94 calories per centimeter squared per second. Using the conversion that 1 pound of TNT has the energy equivalent of 2,200,000 calories, the solar constant, in pounds of TNT equivalent per square foot per second, is .000819. The solar constant can be found in Krafft A. Ehricke, *Space Flight*, vol. 1, *Environmental and Celestial Mechanics*, ed. Grayson Merrell (Princeton, NJ.: D. Van Nostrand Co., Inc., 1960), 141-42. For the conversion of TNT energy equivalents to calories, see *Nuclear Explosions and Their Effects*, with a foreword by Jawaharlal Nehru (Delhi, India: Publications Division, Ministry of Information and Broadcasting, Government of India, 1958), 27-28.
17. The certainty of military satellite position locations is given in Fred Lawrence, "Satellite Position Management" (Paper presented at the 1981 Air University Airpower Symposium, February 1981, 7. (SECRET--Information extracted is unclassified.)
18. Frank H. Shelton, "Satellite System Survivability," *Proceedings of the 1983 Symposium on Military Space Communications and Operations, 2-4 August 1983* (Colorado Springs, Colo.: Electrical Engineering Department, US Air Force Academy), 29-31.
19. Ibid., 30.
20. In the 1960s, the United States did limited high-altitude nuclear testing over Johnston Island in the Pacific. Dan W. Hanifen and William G. Kuller, "Fragility of Space Operations in a Nuclear War" (Paper delivered at the 1981 Air University Airpower Symposium, Kirtland AFB, N.Mex.: Air Force Weapons Laboratory, September 1980), 26-28.
21. As a measure of the impact, 85 nations are members of the International Telecommunications Satellite Organization (INTELSAT), 138 nations receive satellite-derived meteorological data through the World Meteorological Organization, and 45 nations have received data from the US earth resources program, which uses the LANDSAT satellites. Science Policy Research Division, Congressional Research Service, Library of Congress,

World-wide Space Activities, a report prepared for the House, Subcommittee on Space Science and Applications of the Committee on Science and Technology, 95th Cong., 1st sess., September 1977, 91-95.
22. A common proposal is a retrograde geostationary satellite killer--that is, one that orbits in the opposite direction (westward) from all the other satellites in geostationary orbits. Proponents of the retrograde satellite killer do not address the enormous launch vehicle required to achieve such an orbit. The retrograde satellite would either have to be launched against the earth's rotational velocity or undertake expensive orbital plane changes once in orbit. For eastward launches, a rocket benefits from the earth's rotational velocity which adds about 1,100 feet per second to that provided by the engines (like jumping off a merry-go-round in the direction of rotation). Westward launches would lose the benefit and have to overcome the rotational velocity for a total deficit of 2,200 feet per second. Although I have heard the retrograde geostationary satellite killer proposed at symposiums, I have never seen it proposed in writing.
23. The study of the dynamics of satellite motion usually starts with the ideal two-body problem, which assumes that the only forces acting are the ideal gravitational forces between the satellite and the central planet, with both bodies homogeneous and spherical. Based on these assumptions, the motion of a satellite is very uncomplicated and in accordance with Kepler's laws. Real-life effects that cause deviations from this ideal motion are called "perturbations" because the motion is perturbed from the ideal by many forces that are very difficult to quantify. The perturbing forces account for the unpredictable motion. Ehricke, 262-65, 407-10.
24. "For routine studies, general perturbation techniques normally provide orbital element set accuracies on the order of 12 kilometers or less in positional error. When extremely accurate results are required, special perturbation routines (which consider more of the forces that affect satellite motion) can be used. For example, element sets on selected satellites in nearly circular 800 kilometer altitude orbits can normally be maintained with a positional error of less than 1 kilometer for a three day prediction." Col Robert M. Kronebusch, USAF, "USAFs Roles in Space Surveillance," *Proceedings of the Sixteenth Space Congress*, 25-27 April 1979 (Cocoa Beach, Fla.: The Canaveral Council of Technical Societies, 1979), 2-16 to 2-21.
25. A description of the space mine and its assumed value against geostationary satellites is contained in Col Robert B. Giffen, USAF, *US Space System Survivability: Strategic Alternatives for the 1990s*, National Defense University Monograph Series No. 82-4 (Washington, D.C.: National Defense University Press, 1982), 39.
26. Near the end of the nineteenth century, naval men feared that the torpedo boat would doom the battleship. For a time, some European countries even stopped building battleships because of the torpedo boat threat. The answer to the torpedo boat was the torpedo boat destroyer (the forerunner of today's destroyer), which used quick-firing guns to counter the boat's speed. Bernard and Fawn M. Brodie, *From Crossbow to H-bomb* (Bloomington: Indiana University Press, 1973), 166-67; William E. Livezey, *Mahan on Sea Power* (Norman: University of Oklahoma Press, 1947), 57.
27. Department of the Air Force, *Fiscal Year 1984 Air Force Report to the 98th Congress of the United States of America*, 1983, 37.
28. J. M. Stagg, *Forecast for Overlord* (New York: W. W. Norton and Company, Inc., 1971), 26.
29. The Soviet ASATs have an orbital period on the order of 100 minutes and complete their mission in one to two orbits. Perry, 328-35.
30. The Soviets have argued that broadcasting across national boundaries violates a country's sovereign rights and reserves the right to destroy offending satellite systems. Lt Col Donald S. Harlacher, "On Direct Broadcasting," *Air University Review*, September-October 1983, 92-93.

CHAPTER 6

THE HIGH-GROUND DOCTRINE:
STRATEGIC FORESIGHT OR ILLUSION?

“Star Wars” and “Buck Rogers” were two common expressions used in reaction to President Reagan's March 1983 speech in which he challenged American scientists to develop a technology for ballistic missile defense (BMD).(1) Even though the president did not mention space or “death beams,” his speech was interpreted as advocating death beams in space.(2) This interpretation conflicted with some beliefs widely held by the American public. After almost 25 years of the space sanctuary doctrine, it seemed that the American public was being asked to participate in a heretical reformation. This reformation seemed to require one to embrace a theology based on science fiction as a substitute for the utopian belief that space would remain a peaceful sanctuary.

Furthermore, the belief in the sanctity of the deterrent strategy also seemed to be under attack. After being held hostage by the atomic bomb for more than 25 years, the public was being asked to believe that “space” technology would place the nuclear genie back in the bottle. In light of the new science fiction theology, this part of the reformation was particularly difficult to swallow because the BMD debate of the late 1960s and early 1970s had created certain impressions. One was that BMD was destabilizing and would increase the likelihood of nuclear wars. Another was that the entire antiballistic missile (ABM) issue had been solved forever by the Antiballistic Missile Treaty.(3) President Reagan's speech required such radical changes in current belief structures and such enormous faith in technology that even in a nation of true technology worshipers it was skeptically dubbed the Star Wars speech, after the title of a popular science fiction movie of the time.(4)

While the president's speech may have caused confusion, concern, and just plain disbelief among the general public (or at least the press), it elated high-ground doctrine disciples.(5) The leader of the free world had indicated that ballistic missile defense was a worthwhile goal even though he did not endorse a specific concept or even space basing. In the disciples' view, the president had declared that he would accept the doctrine if a technology could be found to support it.

The extensive debate over the merits of proposed BMD technology cannot be resolved here. Although the president might have had other technologies in mind, the space-based laser is probably the most frequently proposed BMD technology. Some scientists believe this technology may be ready sometime toward the end of this century if there is a national commitment and a level of effort similar to the Manhattan Project.(6) Others argue that the laser technology will never reach the stage that will allow ballistic missiles to be killed from space. On another tack are those who argue that laser technology will develop but countermeasures will develop just as rapidly, so that the end result will be a waste of money.(7) Unfortunately, only time and money will answer the technological feasibility question.

Nevertheless, we can examine the logic that leads to the postulate that BMD is worthwhile. This examination will consider the characteristics of space forces that imply a space-based BMD system would be preferable to a terrestrial one. In addition, the assumption that such a

generalized hypothetical system would allow the replacement of what critics term a mutual assured destruction (MAD) concept must be considered. A subset of this question that also must be addressed is whether space-based BMD has any value if it does not portend replacement of the MAD concept. Finally, would such a system, as advocates claim, move wars to space?

Basic Beliefs of the High-Ground School

The genesis of the high-ground doctrine is found in the belief that the deterrent strategy is seriously flawed. In the high-ground view, a strategy that "protects" a nation by holding the population hostage to the threat of mutual suicide with an attacking nation is both militarily and morally bankrupt. By defining stability between the nuclear superpowers as mutual vulnerability to a nuclear attack, it negates any practical political objective for the use of nuclear weapons and leaves a US president with only the choice of irrational vengeance should deterrence fail. With such a strategy "mankind can do no more than wait for the first global nuclear war to begin, hoping all the while against rational hope that deterrence, unlike other human creations, will not eventually prove fragile or imperfect."(8)

High-ground disciples argue that the basic tenet of the deterrent strategy-- that there can be no effective defense against the nuclear weapon--is not only outmoded but has become dogma that inhibits the development of effective defenses. History illustrates that no weapon has ever conferred permanent advantage to either the offense or defense. Unfortunately, the search for a technology to counter the nuclear-tipped ballistic missile (the most difficult delivery mode to defend against) has been impeded by the belief that defensive systems are destabilizing and provocative under a deterrent strategy.(9) In fact, one segment of the high-ground school contends that off-the-shelf components could be used to build an imperfect but useful BMD system today, but the offensive preeminence dogma has excluded this alternative.(10)

An Examination of High-Ground Beliefs

The school believes that BMD technology is not only possible but provides the best opportunity to compete with the Soviet Union. Adherents see the technical problems in developing the space-based laser BMD as solvable in the engineering realm. Furthermore, they argue that because of the US lead in space technology, typified by the space shuttle and our ability to miniaturize satellite components, the United States could redirect the competition from its current terrestrial offensive orientation to a space-based defensive one. In sum, we could make the Soviets play the high technology game in our extraterrestrial court.(11)

The high-ground school looks to space as the home of the BMD system for several reasons other than the assumption that we have a technological lead. Space basing allows the possibility that ballistic missiles can be negated in their boost phase while they are still over the enemy homeland.(12) This solves several problems that plagued previously proposed BMD systems. Systems that would use nuclear-tipped defenders over the United States always raised questions as to the value of stopping incoming nuclear warheads if the defenders did similar damage. In addition, the development of multiple reentry vehicles gives boost phase defense an advantage over terminal defense because all the warheads are still in one basket during the boost phase.

Finally, terminal defense protects Americans but not our European allies. Boost phase defense, however, could stop the missile regardless of target.

Replacement of the MAD Concept

Not only is the high-ground doctrine preferable to the current MAD concept, but its advocates also point to the MX basing controversy as evidence that the offensively oriented deterrent strategy is on its deathbed. The difficulty in determining a survivable basing mode for the MX indicates that our strategy can no longer rely on the construction of improved offensive capabilities using only passive survivability measures for defense.(13) Active defense would not only compound an enemy's calculation of victory using a first strike but also may be cheaper in the long run than adding more empty shells to complicate a missile shell game. Supporters of the doctrine argue that a defensive strategy is needed because the offensive strategy was seriously flawed to begin with and has become outmoded as missile accuracy and firepower have increased. Therefore, in the high-ground vernacular, the offensive concept known to critics as mutual assured destruction must be replaced by a defensive strategy called mutual assured survival.

However much one would like to believe in assured survival as a substitute for assured destruction, there is little hard evidence to support the basic high ground tenet that space forces can overcome the preeminence of the offense. Both the public and most military professionals are uneasy with a strategy that demands rational behavior and no catastrophic human errors from both sides; however, wishing it didn't have to be that way doesn't make a new strategy come true. Neither does a belief in technological possibilities provide a firm foundation for any new doctrinal tenet (although there are numerous examples where new military technologies were overlooked or misused because doctrine had become dogma).(14) Nor does a belief that a breakthrough will occur in space support the high-ground approach. The logistical constraints in deploying and maintaining forces in space must be weighed against the advantages of these hypothetical future weapons.

Advocates contend, however, that the high-ground doctrine is a future doctrine that is not based solely on space weapons. They concede that proposed off-the-shelf, space-based BMD systems will only be a crude first step. According to their future deployment plans, space-based directed energy weapons will become a part of a layered system that includes ground-based point defenses. Even these future layered systems will not swing the balance totally in favor of the defense but must be combined with civil defense measures to protect the population.(15)

Does a strategy that partially relies on civil defense of the American citizenry assure survival? High-ground advocates base their criticism of the MAD concept on a belief in the continuing shift of the offensive/defensive balance. In their view, technological advances will shift the balance so that a perfect defense or offense will probably never exist or at least will not exist for long.(16) According to their own fundamental doctrine, one cannot expect a technology that shifts the balance totally in favor of a leakproof defense. In the nuclear age, the survival of any population cannot be assured because, even in the face of an almost perfect defense, an enemy can apply his nuclear weapons in a city-busting strategy. If only a few nuclear weapons get through the defenses, enormous numbers of casualties could occur. The distinction between

assured destruction and assured survival might be lost on these casualties. No imperfect defense can put the nuclear genie back in the bottle, and based on the high-ground school's own fundamental beliefs in the nature of war, assured survival of the American population is a myth.

A closer examination of the high-ground doctrine indicates that assured survival applies to a nation's population only in an indirect way. Because the high-ground doctrine is based on the tenet that future space-based systems can shift the offensive/defensive balance but not totally unbalance it in favor of the defense, the strategy supported by the high-ground doctrine is merely a variation of the deterrent strategy with an active rather than passive defense.(17) From a simplified viewpoint, passive defenses based on hardening of ballistic missile silos reduce the victory calculation to one involving the kill probability of the offensive weapon against the hardened target (neglecting the other legs of the Triad and ignoring the fact that long-range ballistic missiles have never been tested in combat). Active defense adds new variables to the problem--the effectiveness of the defense, which forces will survive, and so forth.(18) Therefore, active defense implies that some of the *retaliatory capability* is assured of survival. In the face of an active defense, an enemy contemplating a first strike will be faced with extreme uncertainty in his attempts to calculate victory and thus will be deterred from initiating a nuclear war.

A strategy balanced between the offense and defense may improve deterrence but would offer only some of the advantages proposed by the high-ground school. An imperfect defense would not assure that populations will survive a full-scale nuclear war caused by an irrational act by one of the superpowers. In fact, there may be some truth to the argument that good defenses make nuclear war more likely since they may cause leaders to be too confident that their country can survive such a war. Nevertheless, the strategy would provide some protection from accidental missile launches and third country “terrorist” launches of nuclear weapons.

In sum both as current and future doctrine, the high-ground doctrine has been the victim of false advertising, but should not be disregarded because it has been oversold. No off-the-shelf hardware is available, even in the most liberal technological forecasts, that could change the current deterrent strategy. Some evidence (the MX basing problem) does indicate that passive defensive measures can no longer suffice to protect fixed terrestrial targets. As mentioned in the previous chapter, the value of space as an observational high ground along with real-time data processing may make mobile replacements to the fixed ballistic missile (like Midgetman) almost as vulnerable in the future. Therefore, a strategy goal to restore some balance to the defensive side seems prudent.(19) Furthermore, no future technology, whether space or terrestrially based, seems likely to allow an assured survivability strategy. The best that can be hoped for is an improved deterrent strategy over that provided by a reliance on offensive weapons. Finally, space-based technologies should be pursued in looking for BMD because of the inherent advantages available in boost phase intercept, but the constraints imposed by space-basing must not be overlooked.

Space Weapons and Space Wars

In addition to the technological advantages, high-ground disciples focus on space-based defense for another reason: the belief that such systems ultimately will move wars to that remote, largely uninhabited environment.(20) According to this belief, space-based BMD systems will have

such high strategic value that nuclear wars will not be fought in the terrestrial environments until one of the opponents' space-based BMD system is destroyed. The winner of the space war will have such an advantage that the loser will surrender rather than face certain annihilation. This argument seems to be based on the idea of the perfect defense, which has already been found wanting. Nevertheless, even an imperfect space-based defense may change the nature of war. Before considering war in the space age, the general characteristics of a space-based BMD system need to be explored.

Several characteristics of a spaceborne BMD system can be determined from the nature of motion in space. Because space vehicles cannot loiter over a given spot on the earth except at geostationary altitude (other factors to be described later mitigate against geostationary basing), a spaceborne BMD system (using either lasers or projectiles) will consist of a constellation of satellites that provide coverage by sequential passage over the enemy's launch sites. The number of satellites required for continuous coverage will depend on the deployment altitude. One suggested system, for example, requires 432 vehicles because it is deployed at very low altitude.(21) Other systems at higher altitudes may need as few as 18 satellites.(22) In addition, based on the discussion of space vehicle motion in chapter 5, these vehicles will be quasi-positional because of the need to cover the launch sites. Maneuver of individual vehicles would cause loss of coverage, although the whole constellation could maneuver in unison without affecting coverage. The deployment scheme might be best described as a rotating Maginot line.

Deployment altitude will. depend on the weapons carried and their range capabilities. Systems which kill missiles using projectiles will be stationed at relatively low altitudes because of the time required to descend and make the intercept even with the relatively high velocities that can be achieved in the absence of an atmosphere. The deployment altitude of laser weapons will largely depend on laser power. Even in the space void, a focused laser beam will diverge over distance much like the beam of a flashlight pointed at a distant object. As with the flashlight, the amount of laser energy that can be focused on the target will diminish with distance. Higher energy beams can ameliorate this problem, but there will be a distinct relationship between altitude and beam energy (less beam power means that lower altitude deployment--and more vehicles--are required for coverage).(23)

In addition to divergence, the attenuation of a laser beam by the atmosphere will seriously affect the target coverage provided by one laser platform. Atmospheric attenuation of a laser beam is much like the dispersion effects of fog on a car's headlight beams. In addition to this dispersion, the atmosphere has several other detrimental effects on laser beams that limit not only their lethal range but also their pointing accuracy. The upshot of these atmospheric effects is to limit the ability of a laser weapon to traverse much of the atmosphere while still retaining enough energy to destroy targets. For a space-based laser shooting at targets near the earth's surface, the best position for the laser carrier is directly over the target because in the overhead position the laser beam traverses the least atmosphere. As a result, the destruction coverage of a laser platform will be much smaller than line-of-sight coverage. Put another way, an observer on the laser battle cruiser would be able to see many more targets than the laser beams could effectively strike.(24) Increasing beam power can lengthen the laser's range by overcoming some of the atmospheric effects, but the combined effects of beam divergence through space and atmospheric

attenuation will cause the deployment altitude (and therefore the number of platforms required) to be heavily dependent on beam power.

With this brief look at the basic characteristics of a space-based defense, we can return to the question of the nature of wars if and when such systems become available. Many seem to believe that such systems will start wars. They contend that US deployment of a space-based BMD system before the Soviets acquire a similar system would force the Soviets to stop our deployment or face serious disadvantages in terms of strategic balance. This idea seems to be behind President Reagan's offer to share BMD technology with the Soviets.

This postulated Soviet reaction seems to be based on two assumptions: that the initial system deployed would be extremely effective and that its deployment would take the Soviets by surprise. It appears from the previous discussion that the initial BMD system deployed would have less than whole earth coverage, that it therefore might have limited effectiveness against ground-launched ballistic missiles, and that it might possibly provide no defense against submarine-launched missiles. As for surprising the Soviets to the extent that they would have very little time to develop systems to counter our BMD, that seems a forlorn hope. If the system followed normal US development schedules, the Soviets would probably have more than 10 years to counter our BMD system directly or indirectly. These counters could include the development of mobile missiles to compound the coverage problem, emphasis on bombers and cruise missiles, construction of additional sea-launched ballistic missiles, development of laser-hardening techniques, negotiations to limit the deployment of BMD systems or ballistic missiles, or development of a balancing BMD system. Many avenues more prudent than starting a war over US BMD deployment are open to the Soviets.

Suppose, however, the Soviets decided on an aggressive response and declared overflight for BMD purposes unacceptable. What Soviet capabilities are necessary for such a strategy, and what are the possible US reactions? As discussed in the previous chapter, the only requirement for such a denial strategy is weapons of the current ASAT ilk. On the other hand, if the US reaction were limited to actions in the space "theater," the US strategy in response would have to depend on defensive weapons to defend the BMD system at least until it was completed. Some argue that the system ultimately will be able to defend itself; unless it can be placed in orbit surreptitiously, however, it will in all likelihood require initial defense. The United States could react in some other environment--for example, take retaliatory action in a terrestrial environment. A strategy based on retaliation in kind would have the shortfalls discussed in chapter 5 and, in the final analysis, may not be able to secure deployment of the BMD system. The United States could also react by starting a nuclear war, but conducting a nuclear war to field a deterrent capability designed to prevent a nuclear war does not make any sense. Hence, the ability to establish space control (i.e., defend a fledgling ABM system) could be a prerequisite to the deployment of a space-based BMD system.

Would space-based BMD systems cause wars to move to space? Or put another way, would the US and Soviet populations watch like spectators at the Roman games as spaceborne gladiators decided which population would be eaten by the lions? This scenario also seems based on the idea of perfect defense; in other words, the loser in the space games would be totally disarmed while the winner would have a perfect defense. The real outcome would probably be a

destabilized world, where the space war loser could no longer afford to take a terrestrial first strike and would have to adopt procedures such as launch on warning. The winner would also be in a precarious position because the opponent could regain some advantage by preempting.

In the final analysis, starting a space war to gain a strategic advantage might be somewhat like starting a naval war for the same reason. If an enemy's ballistic missile submarines could be destroyed in one quick stroke, would such an attack provide any advantage in the nuclear age? Not unless the enemy's submarines were his only nuclear retaliatory capability. Such scenarios are only peripheral issues to the underlying fundamental doctrinal question, "What logical political objective can justify a nuclear war where even the winner suffers millions of casualties?" No matter what happens in the space theater preceding a nuclear war, the issue of who wins or loses will be determined by the absence or presence of nuclear clouds over the homeland.

This is not to argue that there will not be wars in space. As mentioned in chapter 5, if no capabilities exist in space other than observational ones, the nation that can establish control in the environment may have a decided advantage in a conventional war. Control is an important prerequisite in the space environment just as it is in any other environment.

In conclusion, the high-ground doctrine has some merit even though the disciples overstate its value. Deterrence is an uncomfortable strategy, but before it can be discarded there must be a practical alternative. Assured survival as proposed by the high-ground doctrinaires is not a practical alternative. Nevertheless, it is time to reject doctrine based on the preeminence of the offense and, technology willing, pursue a better state of deterrence through an offensive/defensive balance. Space may be a preferable location for BMD, and space-based BMD technology should be a priority effort; but the promise must be balanced against the practical logistical limitations associated with the environment. A prerequisite for space-basing BMD or winning a terrestrial war is space control.

NOTES

1. See, for example, Richard Mathews, "False Promise of Reagan's 'Star Wars' Defenses," *Atlanta Journal*, 29 March 1983, 4; and James Coates, "Reagan's 'Star Trek' Scenario: Sci-fi or the Future," *Chicago Tribune*, 3 April 1983, sec.2, 1.
2. "President's Speech on Military Spending and a New Defense," *New York Times*, 24 March 1983, A-20.
3. For a discussion of these issues relative to a space-based laser ballistic missile defense, see Keith B. Payne and Rebecca V. Strode, "Space-Based Laser BMD: Strategic Policy and the ABM Treaty," *International Security Review*, Fall 1982, 269-88.
4. See, for example, Lou Cannon, "Making Space War Defense Look Like 'Star Wars' Commercial," *Washington Post*, 28 March 1983, 3; and James A. Wechsler, "Star Wars Strategy Is out of This World," *New York Post*, 29 March 1983, 5.
5. Gregory M. Lamb, "Anti-missile Defense Is Feasible Now, Says One Advocate," *Christian Science Monitor*, 14 April 1983, 7.
6. Walter Andrews, "Teller Foresees Space Defense Working in Less Than 7 Years," *Washington Times*, 30 March 1983, 1.
7. Kosta Tsipis, "Laser Defense Is off the Beam," *Los Angeles Times*, 30 March 1983, pt. 2.5.
8. The best statement of the philosophical basis for the high-ground doctrine. Lt Col Barry Watts, USAF, and Maj Lance Lord, USAF, "Beyond the Missile Age: How to Think about Military Competition in Space," a paper

presented at the US Air Force Academy (USAFA) Military Space Doctrine Symposium, 1-3 April 1981, published in a book of readings compiled by Peter A. Swan, 4 vols. (Colorado Springs, Colo.: USAFA, June 1981), 4:982.
9. The specifics to support the high-ground philosophy can be found in Lt Gen Daniel 0. Graham, USA, Retired, *High Frontier: A New National Strategy* (Washington, D.C.: High Frontier, 1982), 21-25.
10. Ibid., 7, 119-28.
11. Ibid., 17-21.
12. Ibid., 135-45.
13. Ibid., 3.
14. Several examples are contained in a speech by Professor I. B. Holley titled "Horses, Airplanes, and Spacecraft: A Search for Doctrine," presented at the US Air Force Academy Space Doctrine Symposium and published in *Military Space Doctrine: The Great Frontier.*
15. Graham, 150-55.
16. Ibid., 23.
17. A realistic view of the strategic value of space-based defense is presented in Payne and Strode, 269-88.
18. Graham, 4.
19. Midgetman is a small, single-warhead, mobile ICBM seen as a replacement for MX by the Scowcroft Commission. "The Scowcroft Revolution," *The New Republic*, 9 May 1983, 7-10.
20. Graham, 3.
21. Ibid., 119-25.
22. Edgar Ulsamer, "The Long Leap toward Space Laser Weapons," *Air Force Magazine*, August 1981, 58-64.
23. Ibid., 63.
24. The limitations of lasers as BMD weapons are described in Kosta Tsipis, "Laser Weapons," *Scientific American*, December 1981, 51-57.

CHAPTER 7

THE CONTROL SCHOOL: HISTORICAL ANALOGY OR FALLACY?

The United States was propelled into the space age by the same Soviet rocket that launched Sputnik, and the trip was turbulent. At first the Eisenhower administration miscalculated Sputnik's impact and attempted to downplay the Soviet achievement.(1) Although President Eisenhower didn't think Sputnik increased the threat to national security "by one iota," the American public soon knew better.(2) America's seemingly insurmountable technological prowess in matters military had been upstaged by "those backward Russians" who couldn't even build a workable ballpoint pen.(3) Moreover, Sputnik's launch demonstrated that the Soviets had the capability to launch ballistic missiles to global ranges. The United States was threatened not by the insignificant little ball in orbit but by the demonstration of the Soviet technological capability to build an unstoppable bullet that could carry an enormous H-bomb like the one the USSR tested three days after Sputnik's launch.(4)

Space vehicles were not to become a threat until the Soviets started testing their fractional orbital bombardment system (FOBS) in the late 1960s. Nevertheless, Sputnik heightened an already raging doctrinal debate among the services over roles and missions. A year before Sputnik, a bitter debate between the Army and Air Force over the operational ownership of ballistic missiles had been settled in favor of the Air Force (Army missiles were restricted to 300-mile ranges).(5) However, all three services had some capabilities to compete for the space mission. The Army was in the lead with its Jupiter and Thor missiles, the Navy was working hard to perfect the Vanguard, and the Air Force was launch testing the Atlas missile.(6) Based on these capabilities, all of the services expected to be competitive for the space mission.

The "Winner" in the space roles and missions contest was not one of the services, but an interloper--the National Aeronautics and Space Administration (NASA). Based on the sanctuary doctrine's value in supporting the deterrent strategy, the Eisenhower administration implemented the sanctuary doctrine and formed an organization to civilianize space. Congress reserved a role for the military in space that was eventually assigned to the Air Force, but as a result of the sanctuary doctrine the space environment was almost off limits except to systems in support of that doctrine.(7) Gen Thomas D. White continued to preach a control doctrine during his term as chief of staff (1957-62), but the sanctuary doctrine's restrictions on using the words *military* and *space* in the same sentence soon ended the doctrinal debate.(8) Because doctrinal debate was almost forbidden under the sanctuary doctrine, the control doctrine has languished where General White left it--in broad conceptual terms.

Although previous chapters indicate that the shortfalls in the sanctuary, survivability, and high-ground doctrines lead to the requirement to control space (to deny enemy use and preserve friendly use), were General White's instincts correct? Could existing doctrines form the basis for a space control doctrine? Could existing control precepts (e.g., centralized control) from one of the terrestrial environmental doctrines be lifted and applied to space? Would a space control doctrine be an amalgamation of concepts from existing doctrines (General White used analogies from both sea power and air power doctrines), or would space control require an entirely new doctrine?(9) This chapter seeks to answer these questions by analyzing the traditional control

theories for applicability to space. The result of this analysis is a philosophy that undergirds the detailed employment doctrine presented in the last chapter. The analytical method used in this chapter is borrowed from Adm Alfred T. Mahan.

The Mahan Method of Doctrinal Analysis

In his classic, *The Influence of Sea Power upon History, 1660-1983*, Mahan demonstrated a method for examining related military experience for applicability to a new military technology. In Mahan's time, naval men, whose common name--sailors--also describes their perspective, were trying to find a doctrine to deal with the steamship. Little direct wartime experience with steamships was available, and sailing-ship doctrine did not seem to be applicable to ships that could maneuver in any direction with total disregard for the direction of the wind. The only relevant experience seemed to be that of oar-driven galleys that could also be maneuvered regardless of the wind. This experience was also inappropriate, however, because galley maneuverability was limited by the endurance of the crew, and galleys did not have the long-range gunnery available in the steamship age. Mahan used both galley and sailing ship experience to develop a steamship doctrine. His procedure was to define carefully the characteristics of all three types of ships and extract relevant sailing-ship and galley experience by examining the similarities and differences in the characteristics. For example, one of the characteristics of sailing ships was that the opponent on the windward side had the choice of whether to engage. Mahan's analysis showed that the speed characteristic of steamships was similar to the “Wind gauge” characteristic of sailing ships because an opponent with the speed advantage had the engagement choice in steamship battles.(10)

Similarities and Differences in Control Concepts

Through Mahan's procedure we may identify and apply to space power doctrine relevant experience from the control concepts in terrestrial doctrines. The first step is to determine the similarities and differences between each of the terrestrial control concepts and then relate these similarities and differences to force characteristics. Next, based on knowledge of space force characteristics, we can make judgments about the applicability of the concept to space control. Only actual military experience with space forces can confirm these judgments, but analysis can provide a starting point. In some cases, the analysis will not provide clear-cut answers but will be useful in defining the issue more clearly. Throughout this procedure we must keep in mind Admiral Mahan's admonition about the shortfalls of this approach, that while

it is wise to observe the things that are alike, it is also wise to look for things that differ, for when the imagination is carried away by the detection of points of resemblance--one of the most pleasing of mental pursuits--it is apt to be impatient of any divergence in its new-found parallels, and so may overlook or refuse to recognize such.(11)

Control as a Concept

There are several common themes among the terrestrial doctrines that may help define the basis for a space control doctrine. One of these common themes is that control is a capability rather than a condition. In peacetime, nations maintain the capability to control their territory, airspace, and territorial waters. Based on the threat, the most powerful nations also maintain the capability to exert some control over international waters and airspace. That is, navies are designed to have the capability to control friendly sea lines of communication in wartime but do not actively deny others their sea lines in peacetime.(12) In a similar manner, air forces are designed against the most likely threat in order that they have technological superiority and numerical sufficiency to meet the enemy in the battle zone (preferably over his territory), including international airspace, and to establish air control. However, air control is not exercised in peacetime except over one's sovereign territory. One may control his own territory and the airspace above it in peacetime but may only prepare for possible wartime control of international zones.

Does the same type of control concept apply to space forces that operate totally in the international "high seas" of space (vehicular sovereignty) and routinely fly over other nations' sovereign territory (permissible overflight)? The sanctuary doctrine is based on the belief that control of space would be exercised in peacetime if the overflight were not "peaceful." Others argue that the first nation to deploy a space-based BMD will--in fact, must--establish a blockade to deny the opponent the environment.

Will nations attempt to deny nonpeaceful overflight? There are several factors bearing on this question. First, because of the logistical difficulties in deploying to space, only a few nations will have any space power. The number of nations that will have any capability to deny overflight in this century will probably be two--the United States and the USSR. These powerful actors will make the rules, largely ignoring the desires of the nonspace powers. For example, several equatorial countries have claimed sovereignty over the geostationary positions above their territory--a claim ignored by the space powers.(13) Therefore, the overflight rules will continue to be defined by precedents set by the superpowers just as they have been since the dawn of the space age.(14) Second, as was discussed in chapter 4, the superpowers have tacitly agreed that certain space activities such as observation are permissible in support of the nuclear deterrent strategy. It is logical to expect that peacetime observation will continue to be allowed unless some drastic change takes place in the nuclear balance. A third factor is that because of the threat of nuclear war, the United States and the USSR have taken great pains to avoid direct confrontation since the Cuban missile crisis. Thus, the issue prompting one side or the other to attempt to deny overflight would have to be a significant one for the superpowers to break with the past nonconfrontation practice.

Considering these factors and assuming rational behavior, the space powers would change overflight rules only if one or the other deployed space forces that had significant offensive or defensive capabilities. The value of such a system would have to be so great--that is, have such a drastic impact on the nuclear status quo--that the superpowers would be willing to accept direct confrontation and a possible nuclear war over its deployment. In addition, because both nations possess such sufficiency in offensive nuclear capabilities, it seems that the only system that could logically have such an impact would be defensive. Since air defense can be accomplished

without using space, the only critical issue seems to be defense against ballistic missiles. Therefore the questions of denial of overflight rights and space blockade to protect a deployed system merge on the same issue--ballistic missile defense.

The arguments for a blockade strategy in conjunction with the deployment of a space-based BMD come from a coalescence of beliefs from the survivability and high-ground schools. The survivability beliefs are used to argue that the inherent vulnerability of space systems will dictate that enemy forces cannot be allowed into the environment if a ballistic missile defense system is to survive. The high-ground contribution to the blockade strategy argues that space-based BMD will be so valuable that an enemy would seek any means to destroy it. (This same “ultimate weapon” contention seems to be at the seat of the overflight denial argument.) The convergence of these two beliefs is used to argue that the nation winning the race to deploy a BMD system in space will have to exclude the other from the environment. Both of these beliefs--the inherent vulnerability and the perfect defense--have been discussed in previous chapters and found wanting. Therefore, unless some change occurs that provides the perfect BMD system, neither overflight denial nor a space blockade in peacetime seems to be a rational strategy for the superpowers.

General White's vision seemed clear in his description of space control: “The United States must win and maintain the capability to control space. I did not say we should control space. [Space control] does not connote denial of the benefits of space to others.”(15) In sum, space control will be the same as air and sea control--a peacetime capability serving as a deterrent because it can be employed in wartime.

Control Limited to Specific Areas

A second common thread in terrestrial control doctrines is that, in the event of hostilities, control attempts are limited to specific parts of the environment. Naval doctrine talks in terms of control of the sea lines of communication, which include not only pathways over the ocean but also strategic chokepoints such as the Panama Canal. Friendly lines of communication are defended while the enemy's lines are denied. Based on the supposed capability of air power to destroy the industrial base needed to field air power, US air doctrine initially called for air supremacy; that is, it involved the total denial of the air to the enemy through destruction of his aircraft production facilities. Although air supremacy is still a desirable goal, today's air power doctrine describes air control on an as-needed when-needed basis, a concept very similar to the Navy's doctrine on controlling sea lines of communication.(16) Armies attempt to control strategic areas, and actual combat is limited to attempts to “control” front lines. Although all three terrestrial doctrines see superiority in the environment as an ultimate goal, the intermediate goal is control of limited strategic areas. Mahan's point that “fleets come into collision at points to which strategic considerations have brought them” can also be applied to armies and air forces.(17)

Because space is an infinite environment, a space control concept cannot include the total environment; but even in the accessible part of the environment, control attempts will be limited to particular areas. As argued in chapter 6, a nation's military “center of gravity” will still be on terra firma; hence the focus of wars will be the earth. Therefore, control of passage through the

near-earth areas of space would be similar to the naval concept of control of the sea lines of communication. Enemy space forces already deployed past the near-earth orbits could still function; therefore, the control concept would include those strategic cluster points past the near-earth orbits (the Panama Theory).(18) This control concept, which includes lines of communication and strategic areas, makes space control very similar to sea control.

There is another similarity between space and sea control. Even though the ocean areas are not infinite, they might as well have been in the days of the sailing ships. In those days, the great seafaring nations such as Britain were world powers because of their ability to gain access to more of the environment. The same condition applies in space, where a few nations, because of their technological capabilities, are able to exert a "technological control" of the higher altitudes. The primary difference between major and minor space powers is the altitude they can reach with a given payload. Therefore, because of the space lines of communication, the existence of space cluster points, and the spacefaring capabilities of nations, space control is very much like past and present concepts of sea control.

Hierarchy of Control

A third thread of agreement, if not similarity, in terrestrial doctrines is a belief in a hierarchy of control. One aspect of the hierarchy is the belief that control of the enemy's land mass is a sufficient condition for control of his airspace and sea lines of communication. Air forces cannot exist without home bases. Furthermore, unless the enemy has overseas colonies or allies whose ports he can use, control of his land mass eventually leads to control of his sea forces--although sea forces may continue to fight for months after their nation is occupied. Thus, land mass control is a sufficient condition for control of the air and ultimately the sea.

The hierarchy also works from the top down, with air control being a necessary condition for control of land and the seas. Naval experience indicates that control of the air is a prerequisite for control of the seas. In the words of retired Vice Adm. John T. Hayward, the former president of the Naval War College, "Isn't it strange after all these years that people still don't recognize that the battle on the sea goes to the force that has superiority in the air?"(19) Although air power is not decisive in itself, a large-scale conventional land war generally cannot be won without control of the air. Therefore, control of the air is necessary but is not a sufficient condition in itself for control of the sea and ground.

Fitting space control doctrine into these two pecking orders is significantly more complicated. Land control or air control will eventually result in space control because space forces, like naval forces, will wither and die without an umbilical to home territory. However, because unmanned space forces are designed to last for up to a decade without replacement or repair, it is not difficult to imagine, for example, guerrilla forces continuing to use space forces (e.g., communication satellites) long after home territory is occupied.

Furthermore, because of their altitude sustainability, space forces might still be able to have an impact on the war even after the homeland is occupied. Thus, land and air control might be considered an insufficient condition for prompt control of space and might be indecisive in defending against space-based attack.

In addition, sea control may seriously restrict access to space because most current boosters must fly over great areas of the ocean before they reach space. The future development of a plane that can operate in both air and space may change the impact of sea control on space control. Nevertheless, in the near term, control of the terrestrial environments will eliminate logistical support to the space environment and dictate ultimate control of space.

Was General White correct when he predicted, “Just as in the past, when our capability to control the air permitted our freedom of movement on the land and sea beneath, so, in the future, will the capability to control space permit our freedom of movement on the surface of the earth and through the earth's atmosphere”?(20) The examination of future warfighting benefits of space forces in chapter 3 led to the conclusion that the primary contribution of space forces would be their observational capabilities. In the far distant future, space forces with expanded functions will be critical assets to the control of the terrestrial environments. Until that time, space control will be an important ancillary to control of the terrestrial environments but not by any stretch of the imagination a necessary one. This may be best said by substituting the word *space* for *sea* in a naval doctrine phrase--securing control of space sets up conditions for victory, but the final decision is usually reached on land.(21)

Advantages at Environmental Boundaries

Another common theme in terrestrial doctrines is that one of the terrestrial forces has a logistical and therefore a combat advantage at the environmental boundaries. In the days when the primary naval weapon was the long-range gun, ships were at a distinct disadvantage in battles with fixed shore installations. A large part of the advantage was due to logistics. Shore batteries had heavier guns, were not restricted to the size of their magazines, and had no weight restrictions on their armor. Today, ground-based aircraft have logistical advantages against carrier-based aircraft in terms of range, payload, and so forth. Conventional wisdom is that carrier-based air power cannot win against land-based air power.(22) The proliferation of small, cheap missiles that can shoot down multimillion-dollar aircraft has also restricted the freedom of movement of aircraft at low altitudes. Just as naval forces used to stay out of the range of shore batteries and today avoid areas threatened by shore-based air power, air forces must avoid the disproportionate danger from ground fire at low altitudes. In sum, logistical considerations give some forces advantages near the environmental boundaries.

This same trend is already apparent with space forces. The US ASAT will be able to threaten low-orbiting spacecraft much like the shoulder-fired missile threatens aircraft. This type of ASAT has several logistical advantages. First, because it never achieves orbital velocity, much less launch energy is required to get it to a given altitude than is required to place the same weight in orbit, and the launch vehicle can be small and reusable--an F-15, for example. Second, since it is not designed to operate for long times in orbit, it can be much simpler and much smaller than its target. Third, an ASAT hit is a sure kill because of the tremendous destructive effects of hypervelocity impact and the infeasibility of placing very heavy armor on space vehicles. Countering these advantages is the fact that for space forces, altitude is security against ground-based threats. Against targets at higher altitudes, even small ASATs like the miniature homing vehicle require increasingly larger launch vehicles. Therefore, the ASAT rapidly loses

much of its launch advantage as the target's altitude increases. In addition, once the ASAT climbs above the atmosphere and the covering effects of weather, the ability of the target to see the threat coming and to react improves with altitude. Thus, there is a certain altitude which is a dividing line where the advantage shifts from the offense (the ASAT) to the defense.(23) The exact location of this line will be determined by experience and will fluctuate as technology changes the relative offensive and defensive advantages.

Forces Organized Geographically or by Mission

Another common theme in terrestrial doctrines is that forces are operationally organized either by geographical area or mission. The United States European Command and the Pacific and Atlantic fleets are examples of organizations with geographical areas of responsibility. Military Airlift Command as a specified command and naval task forces are examples of forces organized according to mission responsibilities. At first glance, the Air Force principle of centralized control seems to fit into neither of these categories; however, it too is an example of geographical organization which, when examined in historical perspective, can be applied to space forces.

During the early stages of World War II, it became obvious that organizing air forces around the same geographic boundaries as ground forces unnecessarily restricted their employment. The commanders of army units to which aircraft were assigned had a geographically limited perspective which was not as great as the range capabilities of the aircraft. As Field Manual 100-20 so eloquently stated, “Air power must be centralized ... if this inherent flexibility and ability to deliver a decisive blow are to be fully exploited.”(24) Air forces are now organized along broader boundaries than army forces--boundaries that do not restrict their flexibility. Furthermore, the doctrine requires that vehicles entering the theater on specific missions (e.g., airlift) operate under the centralized control of the theater commander. The doctrine recognizes that there are various users of the airspace but that one authority controls the airspace.

Was General White correct when he applied the idea of centralized control to space forces? Space forces have no restriction on their range; in fact they have unlimited range. Except for those in geostationary orbits, space forces travel around the earth in each orbit and those with an orbit inclined to the equator pass over both the northern and southern hemispheres of the earth. Thus, space forces cannot be said to operate in any confined geographic area. In addition, it is almost impossible to classify them into altitude categories. Some space vehicles like those in the Molniya orbits are very far from the earth at apogee and very close at perigee. It would therefore not be appropriate to divide space forces into southern and northern or high- and low-altitude space commands. The global nature of space forces seems to support General White's argument for “centralized control.”

Nevertheless, under the tenets of the sanctuary doctrine, space forces were organized according to mission. Since military space organizations were forbidden under the sanctuary doctrine, space forces were assigned to organizations whose missions they supported--that is, weather satellites were assigned to weather organizations, communications satellites were assigned to the communications organizations, and so forth. The Soviet ASAT, which could threaten many of these vehicles regardless of mission, highlighted the irrationality of operationally organizing

space forces according to missions. The formation of a unified Space Command, [In November 1984 President Reagan authorized the creation of a unified Space Command.] although it is yet to be assigned operational responsibility for all space vehicles, reflects the correctness of General White's reasoning that space forces should operate under centralized control.(25)

Control Implementation Methods

Although there are many similarities among terrestrial control doctrines, control in the terrestrial environments is implemented using different methods. Land forces can control areas either by destroying the enemy's forces or by occupying territory and defending it. In contrast, air forces do not occupy positions but control their particular environment by the destruction, or the threatened destruction, of enemy forces. Although sea forces can anchor and occupy positions, in practice they behave much like air forces and control by patrolling given areas and destroying enemy forces in these areas. The distinction among control methods is whether the forces can occupy positions or merely pass through them. US Army doctrine makes this point by stating that "only land power can make permanent the otherwise transitory advantages achieved by air and naval forces."(26)

The implementation of space control will have similarities with both land and air control because space forces transit most positions but actually occupy some. Our earthly idea of position is a point fixed with respect to the earth. The geostationary orbits satisfy this definition, and so space vehicles can occupy these positions. It is not clear whether such occupation provides any defensive advantages against space-to-space threats like those that accrue to ground forces. Nevertheless, most space forces merely transit positions, and the primary method of space control will be similar to that of air control--the destruction of the enemy's space forces.

Sense of Timing and Tempo

In each of the terrestrial doctrines there is a different sense of time that impacts the control philosophy. One part of this sense of time is knowledge of how long it takes to deploy to the battle area. This sense is referred to as timing and is demonstrated by Clausewitz in his detailed description of the march in *On War*. For example, Clausewitz describes exactly how long it took a division to march past a given point under various circumstances (road surface, weather, division type, etc.).(27) In a similar manner, the experienced commander of a naval vessel has developed a sense of geography relative to the speed of his ship, ocean currents, weather, and so forth, that enables him to provide good estimates of deployment times without the aid of a map. Both parts of the time sense are highlighted in air power doctrine in the use of the word *speed* as a force descriptor. Speed is used in two contexts. One is as a measure of the time required to go some distance--deployment time.

The second use of the speed characteristic in air power doctrine illustrates the other part of the time sense, which relates to the tempo of the battle. The speed of aircraft contributes to their flexibility attribute--the ability to strike a series of land, sea, or air targets in quick succession. Early air power doctrine described the effect of the airplane on the ground commander's traditional concept of tempo.(28) One measure of the impact of this changing tempo on warfare is illustrated by the German blitzkrieg tactics in World War II. One can argue that the success of

the tactics was partially due to their total disruption of the opponent's sense of the tempo of a land battle. Technology has not drastically altered the speed of naval vessels since the advent of the steamship. If it were not for the airplane, surface naval battles might still be fought at pre-World War II tempos--battles that continued for days over enormous stretches of the ocean before a winner was determined.

In each of the terrestrial doctrines, this sense of timing and tempo strongly impacts the way forces are deployed and employed. For example, naval forces are often positioned near the likely conflict locations because their steaming times are measured in days or weeks. On the other hand, aircraft with worldwide deployment time measured in hours can be based in the continental United States and rapidly deployed to future trouble spots. Army units are described with terms (airborne, airmobile, cavalry, infantry) that also indicate their mobility or timing and tempo characteristics. A recent example illustrating the impact of the sense of tempo on doctrine is the attrition versus maneuver warfare debate. In very simplified terms, the maneuver advocates think that the American experience has resulted in an “attrition warfare” dogma that has blinded us to the advantages of being able to operate at a faster tempo than the enemy.

Some space experience is available regarding timing but almost none regarding tempo. Based on the aerospace fallacy, the initial thinking on the deployment of space forces mirrored Air Force experience. That is, because space forces and air forces supposedly have the same speed characteristic, space forces could be based on land and rapidly deployed to space. Space forces travel at great speeds, but deployment distances are great; moreover, because of the nature of space motion, space vehicles do not travel from point to point efficiently in straight lines. In addition, launching a spacecraft is orders of magnitude more difficult and time-consuming than launching aircraft. As experience has been gained, the deployment doctrine is shifting away from the quick-launch idea to one where backup forces (on-orbit spares) are stationed in the environment. Again, naval experience with slow ships over great distances is more appropriate than Air Force experience for a starting analogy in a space force timing sense. As discussed in the next chapter, the development of an aerospace plane may require a different timing sense for near- and high-earth orbits.

While we have gained some experience regarding timing, the tempo of space wars is an open question. If space wars are fought as envisioned by the high-ground advocates with directed-energy weapons, no terrestrial experience may be analogous. Command and control systems able to keep up with long-range weapons that kill at near the speed of light will certainly stress terrestrial tempo concepts. On the other hand, if space-to-space weapons are projectiles that chase targets through the heavens on paths dictated by the laws of orbital motion, then the naval analogy may be somewhat appropriate. Experienced space commanders will some day have that sense of timing and tempo.

More than 20 years have passed since General White described his vision of a space control doctrine. Experience with space forces indicates that General White achieved only mixed success in predicting the nature of a space doctrine. Experience--or at least logical inference--indicates that he was correct in his prediction that space control would be a peacetime capability to be implemented in wartime. He also recognized that during wartime space forces would vie for space control by destroying enemy space forces and would perform this function most

successfully if organized under a centralized-control concept. His view that control of space would lead to control of the terrestrial environments does not appear to be correct, at least in the near future. Although he did not specifically address space force timing and tempo, his basic premise embodied in the aerospace analogy indicates that he assigned air force timing and tempo attributes to space forces. The tempo issue has not been resolved, but space force experience indicates that a naval timing analogy would be more valid. General White also seemed to see space superiority in the old air power sense rather than as limited control in the naval and later air power sense. He made no mention of the fact that space forces at the airspace boundary would be at the disadvantage. Although General White batted only about .500 based on logical inference, many others have not done that well using hard military experience as a base.

In sum, Admiral Mahan's procedure of examining similarities and differences has provided a broad conceptual framework for a space power doctrine. The next chapter describes some of the brick and mortar that needs to be added to this framework to implement a space control doctrine.

NOTES

1. Philip J. Klass, *Secret Sentries in Space* (New York: Random House, 1971), 18-29.
2. Ibid., 25.
3. A day or two before Sputnik's launch, I read an article in which the author “proved” that the Russians could not build capable ballistic missiles because they were too technologically backward to build even a workable ballpoint pen. Unfortunately, I do not remember the source of the article.
4. Klass, 24.
5. Maj John B. Hungerford, Jr., USAF, “Organization for Military Space: A Historical Perspective,” Research Report No. 82-1235 (Maxwell AFB, Ala.: Air Command and Staff College), 9-19.
6. Ibid., 19-24.
7. Ibid., 35-47.
8. I can find very little in the open literature about control ideas by active duty military authors after General White's retirement. By 1968 the shift from the space control doctrine was so complete that Air Force Chief of Staff Gen J. P. McConnell's acceptance speech upon receiving the Gen Thomas D. White Space Trophy was part and parcel from the sanctuary school. Gen J. P. McConnell, “Our Military Space Efforts,” *Air Force Policy Letter for Commanders*, September 1968, 8-10.
9. For examples of General White's use of both naval and air force analogies, see the transcript of his speech delivered to the Air Force Association's Third Jet Age Conference in February 1958, which is contained in Robert Frank Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force 1907-1964* (Maxwell AFB, Ala.: Air University, 1974), 280-81.
10. Alfred Thayer Mahan, *The Influence of Sea Power upon History, 1660-1783* (New York: Hill and Wang, 1963), 1-6.
11. Ibid., 2.
12. E. B. Potter and Adm Chester W. Nimitz, eds., *Sea Power* (Englewood Cliffs, NJ.: Prentice-Hall, Inc., 1960), 19.
13. Eight of the equatorial nations (Brazil, Colombia, Congo, Ecuador, Indonesia, Kenya, Uganda, and Zaire) have declared intent to claim proprietary rights (much like fishing rights within 200 miles of their coasts) over the geostationary orbits over their countries. The space powers have ignored this claim. House, Committee on Science and Technology, Subcommittee on Space Science and Applications, *Worldwide Space Activities*, 95th Cong., 1st sess., September 1977, 18.
14. Prior to the launching of Sputnik, a principle of international law was that a country owned the airspace above its territory. The Russians did not ask permission to orbit Sputnik, nor did the United States protest the overflight. John Cobb Cooper argues that the United States actually set the precedent several years earlier when it announced that it would launch satellites during the 1957 Geophysical Year and asked no formal permission of other states to do so. The two space powers have been setting the rules ever since. John Cobb Cooper, *Explorations in Aerospace Law*, ed. Ivan A. Vlasic (Montreal: McGill University Press, 1968), 280-85.

15. Gen Thomas D. White, USAF, “Space Control and National Security,” *Air Force Magazine*, April 1958, 80, 83.
16. “Control of the air” may range from full control over the entire area... to local control in a specific battle area. It may also vary by time….” Department of the Air Force, Headquarters Tactical Air Command (TAC), TAC Manual 2-1, *Tactical Air Operations*, 15 April 1978, 4-16.
17. Mahan, 8.
18. Dandridge M. Cole, *Strategic Areas in Space--The Panama Theory* (Los Angeles: Institute of Aerospace Studies, 1961), 1-8.
19. As quoted in *Air Force Policy Letter for Commanders*, 15 August 1982, 2.
20. White, 80.
21. Potter and Nimitz, 19.
22. Adm Thomas H. Moorer and Alvin J. Cottrell, “In the Wake of the Falklands Battle,” *Strategic Review*, Summer 1982, 23-28.
23. Heimach makes the same observation about low-altitude space force survivability against air- or ground-based threats. Col Charles F. Heimach, USAF, “Space Survivability--A Philosophy/Policy Argument,” *The Great Frontier*, 4 vols., comp. Peter A. Swan (Colorado Springs, Colo.: United States Air Force Academy, June 1981), 1:23-42.
24. Field Manual 100-20, *Command and Employment of Air Power*, 21 July 1943, 3-4.
25. “In war, when time is of the essence and quick reaction so necessary, centralized military authority [in space] will surely be mandatory.” White, as quoted in Futrell, 281.
26. Field Manual 100-1, *The Army*, 14 August 1981, 8.
27. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ.: Princeton University Press, 1976), 314-24.
28. This capability of air power is often called “flexibility.” For example, “The inherent flexibility of air power is its greatest asset. This flexibility makes it possible to employ the whole weight of the available air power against selected targets in turn….” Field Manual 100-20, 3-4.

CHAPTER 8

IMPLEMENTING A SPACE POWER DOCTRINE

Analysis of the sanctuary, survivability, and high-ground doctrines has led to the conclusion that the best way to employ space forces is according to a control doctrine. The flaw in the sanctuary school's beliefs is the assumption that space-based observational capabilities can be allowed to remain in sanctuary without negatively impacting the deterrent strategy. The survivability school was built on the false tenet that space forces have inherent vulnerabilities, which led to the conclusion that space wars should and would be retaliation-in-kind affairs. The shortfalls in the retaliation-in-kind strategy highlighted the requirement for a space control doctrine. The high-ground school's belief that space-based ballistic missile defense would alter the offensive/defensive balance to such an extent as to negate the nuclear weapon was also found wanting. However, the analysis showed that space-based ballistic missile defense, if it becomes technologically feasible, would enhance the deterrent strategy. The capability to control space would be a requirement to field and employ such a system. Finally, we have seen that there are elements of terrestrial control doctrines that provide a conceptual framework of relevant experience for a space control doctrine.

The gist of that relevant experience and the analysis in previous chapters is that the capability to control space is a requirement if the United States wishes to remain a space power. Space power is the ability to use the environment in pursuit of national objectives. The United States must have the ability to control space if it is to use that medium to fulfill national objectives in situations where our objectives come in conflict with those of other nations. For these reasons, the space power doctrine recommended in this chapter is based on the concept of space control.

Basic Considerations

Implementing a space power doctrine is not as simple as merely funding, acquiring, and deploying one or more “control” weapon systems. In the eighteenth and nineteenth centuries, the British ruled the sea not because they always had better fighting ships than their opponents but because as a nation they consciously or unconsciously practiced a policy based on the maintenance of sea power. Part of that sea power was embodied in brave men on fighting ships. Part was anchored in a network of overseas bases that not only made Britain a trading nation par excellence but also provided a logistical advantage that could often overcome the enemies' advantages in the quality of their warships. The broad national base required for a nation to become a sea power is illustrated by the fact that military capabilities are not on Admiral Mahan's list of the conditions affecting sea power--geographic position, physical conformation, extent of territory, number of population, character of the people, and character of the government.(1)

Air power and land power control doctrines must also be deeply rooted in rich soil even though the focus is often the technological superiority of a given weapon system. The latest air superiority fighter or “better” tank is the product of the industrial capabilities of the nation, which include everything from the scientific and engineering talents of its people to the maintenance of a healthy civilian aircraft or automobile industry. Furthermore, the most

advanced fighting vehicle must be supported by healthy logistical systems, overseas bases, and the like. Moreover, none of the control doctrines can succeed without well-led, highly motivated fighting men.

Because the implementation of a space power doctrine involves the coalescence of all elements of national power, it is too broad a subject to be covered here; therefore, this chapter is limited in both breadth and depth. Although the critical contributions of the nonmilitary elements of power to space control are widely recognized, this chapter must concentrate only on the military element. Nevertheless, because the military and civilian aspects are sometimes so entwined (e.g., the space shuttle), certain nonmilitary aspects are addressed. The technological depth is also limited. The technical and deployment details of possible "control" weapon systems are left to others and only a general treatment is attempted here. As a result of this limited scope, this chapter is a broad overview of a control doctrine rather than a detailed employment doctrine.

Five Pillars of a Space Control Doctrine

This chapter emphasizes five pillars of a space control doctrine. The first of these pillars is the critically important logistical structure required to make the American presence in space seem as ubiquitous as that of the British seaman in earlier centuries.(2) While the value of military personnel as a critical element in all terrestrial doctrines is intuitively understood, the value of military personnel in space is not. The second pillar of space power doctrine is the human being. The third pillar--a space surveillance system--is relatively unique. It is related to the fact that man's presence in space is needed but will not be routine for many years. The fourth pillar is the control weapons themselves, which are discussed at a conceptual level only. Finally, the space control doctrine cannot be implemented without the proper organizational arrangements. Therefore, the last topic of the chapter and final pillar of the doctrine is a description of the proper organizational doctrine to support the space control beliefs.

Logistical Structure

In relation to all other countries, the United States and the USSR would be space powers even if neither ever deployed a space weapon. The reason is that the logistical problems in traveling to space have denied and will continue to deny the use of the environment to most nations. Many nations use the environment, but only nine have developed a launch capability.(3) Gradations in how efficiently and effectively the nations with a launch capability are able to access the environment result in a pecking order among the space powers. For example, the United States "won" the moon race in the 1960s because of the superiority of our launch vehicles. Today, countries such as India have some launch capability but do not have the ability to access the most desirable cluster points (geostationary and sun-synchronous) either at all or with any significant payload.(4) Launch capability gives the space powers "technological space control," and the United States has significantly enhanced its space power by the development of the space shuttle.

The Space Shuttle. The space shuttle has numerous advantages over the expendable launch systems it replaced. One advantage that will be discussed in more detail later is that the shuttle makes possible man's presence in space on a routine basis. A second although related advantage

is that the shuttle has nullified the need to build bigger boosters to accommodate bigger payloads because it will enable us to assemble structures in orbit from several shuttle loads. Although there is considerable controversy as to whether the shuttle will be cheaper on a per-trip basis than the vehicles it replaced, a third advantage is that it will be cheaper to the user. This apparent contradiction is due to the fact that the government, through its shuttle pricing policy, subsidizes each shuttle trip, thus encouraging space "development."(5) Finally, the shuttle should improve the launch reliability over that achieved with expendable boosters (about 90 percent) and eliminate most of the risk of losing multimillion dollar payloads on the launch pad.(6) By any measure this is not a complete list of shuttle advantages, but these advantages certainly boost US space power and further the capability to achieve a control doctrine.

Notwithstanding these advantages, the shuttle receives criticism in military circles. It relies on soft facilities vulnerably located in coastal areas and must take off and land on flight paths that extend over large areas of nonsecure international waters. In other words, it gives us only a "soft," nonsurvivable capability. Furthermore, the shuttle does not satisfy military "requirements" for an on-demand launch capability. Although it may ultimately be capable of two-week turnaround from each launch site, the shuttle will not be put on alert with payloads in its belly as aircraft are. In sum, military "experience" indicates that the shuttle is a fine peacetime vehicle but does not meet the "usual" military requirements.(7)

Before addressing these criticisms, we need to examine the general characteristics of vehicles like the shuttle that are designed to carry bulk cargo into space. First of all, barring the invention of an antigravity machine, a bulk payload carrier will be a very large vehicle. For instance, even the most efficient rockets have a payload-to-total-vehicle-weight ratio of about .02 (the payload is only 2 percent of the total vehicle weight).(8) Thus, launch vehicles that can deliver 50,000 pounds of payload to low earth orbit will weigh on the order of 2,500,000 pounds. Second, payload-to-vehicle-weight ratios this "good" are attainable only with vehicles that use propellants with severe handling characteristics. The common propellants, liquid hydrogen and oxygen (at temperatures of -423 and -259 degrees Fahrenheit respectively), are not exactly storable under one's kitchen sink.(9) As a result of these vehicle-size and propellant-handling characteristics, bulk cargo carriers will be almost impossible to "harden" (particularly against a nuclear threat) and to configure for on-alert launch.(10)

The criticisms of the shuttle overlook the nature of the bulk launch vehicle and are extracted from beliefs based on air force rather than space force experience. Based on the hierarchy of control developed in the last chapter, control of the air, land, or sea will ultimately result in control of space, because space launch vehicles must either start, pass through, or fly over these environments to deploy. Both air and sea control doctrines concede that control cannot be complete, and thus targets as large as bulk launch vehicles cannot be completely protected by friendly forces and cannot be protected at all from a ballistic missile attack. A second shortfall of the criticism is that it is based on air force rather than space force timing experience. To reiterate the timing beliefs expressed in chapter 7, if space forces are to be brought to bear on most wars, they must be in the environment at the start of the battle. In essence, the criticism is the result of attempts to mold space force launch capability to the air force experience rather than accepting space force experience. This is not to say that on-demand launch capability would not be a useful characteristic, but expecting on-demand launch capabilities from the bulk carrier is not realistic.

One valid criticism of the space shuttle is that it did not turn out to be a total space transportation system. One missing element is the space tug, which was supposed to be an efficient upper stage to deploy payloads from the rather low altitudes reachable with the shuttle to the high-altitude cluster points. When NASA ran into both technical and budgetary problems with the tug, the Air Force "volunteered" to build what was called the interim upper stage (IUS) as a temporary replacement. The Air Force soon ran into its own technical and budgetary problems; and because government agencies do not spend large amounts of money on interim solutions to any problem, the name was changed to "inertial" upper stage, neatly retaining the same IUS acronym.(11)

The IUS's shortfalls are twofold. First the space tug was supposed to be able to take payloads to geostationary orbit and bring back other payloads, or at least itself. The IUS is a one-way vehicle. That is, once it delivers its payload, it becomes space junk. The second shortfall is its size. Fully loaded with propellant, the IUS can deliver 5,000 pounds to geostationary orbit from low earth orbit. In this fully loaded configuration, the IUS weighs approximately 32,500 pounds. Thus, for each 5,000 pounds delivered to geostationary orbit the shuttle must deliver 37,500 pounds to near-earth orbit which in terms of weight is about 60 percent of a shuttle load.(12)

High-/Low-Thrust Delivery Systems. Pointing out these shortfalls is not meant to indicate that the IUS is not a well-designed and well-built state-of-the-art vehicle, but that the original requirements that dictated its design must be reconsidered. Current propulsion systems used for upper stages can be divided into two classes according to the thrust they produce. High-thrust upper stages--chemical and certain nuclear systems--produce their thrust by ejecting large masses of propellants at relatively low velocities. They produce high thrust for short periods of time. Low-thrust systems--for example, solar electric and nuclear electric--use small amounts of propellant but eject them at enormous velocities.(13) They can produce low thrust for very long periods of time. The two important operational differences between these two classes of upper stages relate to travel time and propellant requirements. The low-thrust vehicles are slow movers; they may take a month or more to deliver a payload from low earth to geostationary orbit compared to the hours required for high-thrust systems. While they are fast movers, the high-thrust systems such as the IUS require large amounts of propellants that, in turn, must be delivered by the shuttle to low earth orbit. The high-/low-thrust operational tradeoff is transfer speed versus efficient use of the launch capability.(14)

Based on the air power perspective that faster is better, the Air Force has been unwilling to trade deployment speed for launch efficiency. The IUS results from this perspective, which produces requirements that eliminate the low-thrust propulsive systems as an option.(15) It is as if the Navy decided that deployment speed was the most critical requirement and therefore set requirements that made fast air cushion vehicles the only candidates for naval ships. The naval price paid for this requirement would be decreased combat capability in the battle area. Similar loss of space combat capability will occur if the Air Force continues to use an inappropriate doctrinal concept emphasizing speed over all other requirements to dictate how to conduct military affairs in space.

Space forces have requirements for both the high- and low-thrust upper stages. The low-thrust stages will be the bulk cargo carriers flying regular supply routes from near-earth orbits to the

cluster zones. The high-thrust upper stages will deliver more precious, perishable cargo to these zones. Man will be the most critical of these precious cargos because he cannot be sustained easily in the harsh environment during long trips, and he will not be able to reside as long in the Van Allen radiation belts as would be required on the slow movers.(16) The reasons for carrying passengers rather than hauling robots to space will be developed more fully in later sections.

Space Stations. Besides efficient space tugs, there is a second element missing from the Space Transportation System: space stations. Two different space stations, the civilian Skylab and the military Manned Orbiting Laboratory, were integral parts of the original Space Transportation System. Both programs were terminated before the shuttle was completed.(17) NASA envisions a new space station as the next logical step in building an efficient space transportation system. One advantage of such a station is that it would optimize the use of the shuttle. Currently, shuttle loads consist of one or more satellites mated to their upper stages, which may or may not make a full load. (Shuttle loads are filled out using “getaway specials”--small packages, usually scientific experiments, flown for a nominal fee.)(18) The ability to deliver major components to a space station where, for instance, the satellite could be mated with upper stages would use shuttle payload capability more fully. In addition, many projected military and civilian uses of space (such as the construction of large space structures, materials processing, long-term experiments, etc.) would require long shuttle missions and therefore extend shuttle turnaround time. Without a space station, long mission times would have to be traded off against cargo delivery capability, number of shuttles to be built, and so on. In sum, the NASA view is that a space station is a key element to an efficient transportation system.(19)

The Air Force has been rather cool to NASA's suggestion that the next step in space should be a manned space station.(20) Because a space station would operate in low earth orbit, it would be vulnerable to attack from terrestrial forces that would have an advantage this close to the air-space boundary. Hence, a space station is tagged with the leper-like label, “nonsurvivable.” Second, since its orbit would be designed for easy shuttle access, a space station might not cover any of those areas that contain the military threat. Therefore, the space station as envisioned by NASA has very little military utility as an observation post. Third, as a command and control post, the space station would have no advantages over airborne command and control centers which can rely on maneuverability to survive. Finally, the space station might optimize the use of the shuttle, but the Department of Defense (DOD) has priority over civilian shuttle users anyway.

Again, naval experience counters these arguments. The development of the steamship allowed navies to maneuver regardless of the wind but also made them dependent on coal for energy. Coaling stations were often very vulnerable because they not only were lightly defended but also were attractive targets--both friendly and enemy fleets required coal and using the enemy's coal killed two birds with one stone.(21) Coaling stations did not inflict casualties but were essential to the efficient operation of both civilian and military fleets in peacetime. Admiral Mahan's words about the importance of coaling stations could apply equally well to space stations.

Having therefore no foreign establishments, either colonial or military, the ships of war of the United States …will be like land birds, unable to fly far from their shores. To provide resting

places for them, where they can coal and repair, would be one of the first duties of a government proposing to itself the development of the power of the nation at sea.(22)

The Aerospace Plane. While the shuttle, the high- and low-thrust upper stages, and the space station are elements of a national transportation system that can serve both military and civilian users, one almost purely military transportation capability is required--the aerospace plane. One of the original approaches to solve the space transportation problem was a plane that could fly from the air to space.(23) It was envisioned to be a rather small vehicle that would be launched from under the wing of a very large aircraft at high altitudes. It would have numerous advantages over expendable boosters. It would be fully reusable, capable of delivering cargo to and from space, and considerably cheaper in terms of launch facilities as conventional runways could be used instead of massive facilities like those at Cape Canaveral. Since its first stage would be a reliable aircraft, it could be launched without the severe range safety constraints that restrict the launch azimuths of both expendable boosters and the shuttle (although the earth's rotation would still assist eastward and hinder westward launches). Unfortunately, early in the space age, launch of an aerospace plane plus a payload was not within the weight-carrying capability of the state-of-the-art large aircraft.(24)

Technological advances now make the aerospace plane a possibility. Aircraft engine technology has dramatically increased the weight-carrying capacity of large aircraft, and improved structural technologies (fly by wire, lightweight composite materials, etc.) have made possible an equally dramatic decrease in the weight of an aerospace plane. Based on these improvements, preliminary studies indicate that an aerospace plane may be capable of carrying 10,000 pounds to low earth orbit with an easterly launch.(25)

While not a replacement for the bulk cargo capability of the shuttle, the aerospace plane would have several military advantages in addition to those listed previously. It would provide a sortie vehicle for wartime use near the airspace boundary, where space vehicles are most vulnerable to attack from terrestrial forces. Because it combines the maneuverability of air vehicles with the altitude sustainability of space vehicles, the aerospace plane could take advantage of both attributes to increase its survivability at the boundary.(26) The aerospace plane could be launched surreptitiously from small airfields that may survive if air and sea control is lost. Finally, if refueled by space stations or orbiting tankers, it may also be the fast transfer vehicle to take man and other time-sensitive cargo to space.

Man in Space

A proposed aerospace plane to deliver man to the environment raises one of the most debated questions of military space doctrine: What is the role of military personnel in space? This question is best addressed by starting with a brief historical look at the evolution of man's current role in space.

In the early 1960s, the pressing need was to develop a space capability to support the deterrent strategy. Manned space flight was not a capability in the early 1960s; but based on initial experience indicating the need for man's presence, military programs were devised to put man in space.(27) The first of these was Dyna-Soar, which could have been a precursor to the aerospace

plane but was canceled, partially because of the successful use of space robots for the observational mission.(28) The next military manned space program, the Manned Orbiting Laboratory, was also canceled, partly because of Vietnam-era budgetary problems and partly because key individuals in the DOD believed that man had a limited role in space.(29) It would appear that the "robot doctrine" was correct because robots have been successfully performing the space mission for the first 25 years of the space age.(30)

The fallacy in the robot doctrine is that those cybernetic devices have not been performing wartime military missions but routine peacetime functions under a sanctuary doctrine that excluded the possibility of wartime functions. The requirement for man in the environment is as simple as the difference between peace and war. Clausewitz's maxims on the "friction" of war make this clear. If "everything in war is very simple, but the simplest thing is difficult,"(31) how do we teach robots to handle these simple things that become difficult? If "every war is rich in unique episodes,"(32) how do we program robots to adjust to experiences we cannot foresee? How long will it take to adjust our robots once we have experienced these new events? If "each [war] is an uncharted sea full of reefs,"(33) can robots steer past those uncharted reefs in the dark? G. H. Stine puts it this way: "War is a human activity; it is not conducted by machines that have…no concept of the use to which they are put. Machines do what they are designed or programmed to do--and nothing more."(34)

We will realize that man is required in space when those space robots sink after striking uncharted reefs, are not available for a unique wartime contingency, and cannot adjust when the simplest thing becomes more difficult. In these wartime situations, we will have need in space for what has been called the most capable cybernetic device ever produced in a 150-pound package--the human being. We will not be able to define his function precisely until the fog and friction of war is upon us, but we must learn how to employ man in the environment before then or else add to the fog and friction. Gen Jerome F. O'Malley, an experienced warrior, expresses this same sentiment: "I feel an undefinable but very real sense of urgency--a basic premonition that in some future period we are going to look back and wonder why we were so slow to comprehend the value of man in space."(35)

Space Reconnaissance and Surveillance

Until we learn to use the human being in space, his presence there will be limited; therefore, a third pillar of the space power doctrine is a reconnaissance and surveillance capability to monitor events in space. Current ground-based "space track" systems have severe limitations.(36) Most sensors have difficulty seeing through the atmosphere and thus cannot detect objects above certain altitudes. In addition, geographical restrictions on ground sensor siting limit the coverage. For example, space vehicles in certain elliptical orbits (such as the Molniya) which are inclined to the equator may not be seen because at apogee, over the Northern Hemisphere, they are out of sensor range. At perigee, when they are close enough to see, they are over the Southern Hemisphere where there are few space track sensors. Furthermore, the current space track network was designed to track quasi-positional vehicles, not maneuvering ones. Because quasi-positional vehicles do not stray too far off a predictable path, the tracking procedure is to look in the vicinity of the predicted location to determine an updated location. If the vehicle maneuvers between such observations rather than drifting through space, the whole procedure is

useless and the vehicle is lost to our "eyes." The maneuvering vehicle will become more of a problem as the number of space objects increases, because to be identified after a maneuver, a spacecraft must be distinguishable from the crowd of other space objects.(37)

Space-basing the space surveillance and reconnaissance system is the answer to most of these current shortfalls. Above the atmosphere, sensors will be able to see enormous distances because electromagnetic energy travels almost unattenuated through space. Space-based sensors also have the space equivalent of the global coverage characteristic--that is, they have a view obstructed only by the earth and its atmosphere. By providing continuous coverage of near space, at least, these sensors should be able to see maneuvering vehicles by using some part of the electromagnetic spectrum to detect engine burns. Finally, optical systems may provide images of threatening vehicles, not just notification that something is there. These images will be important because until man is a permanent party in space, space surveillance will be required not only to do the functions (targeting, warning, etc.) normally performed by sensors in the other environments but also to replace man's eyes.

Space Control Weapons

Space-based space surveillance will be required even if the United States relies only on passive survivable measures (maneuvering, hardening, etc.) and ground-based ASATs to "protect" our space assets, but it will be absolutely critical to the employment of space control weapons. Previous chapters have discussed not only the operational but also the strategic limitations of the soon-to-be-operational American ground-based ASAT. This system is of value to deny the enemy the use of low-altitude space but cannot do more. The complete control concept requires weapon systems capable of denying the enemy the strategic areas of space he wishes to use and also of defending US assets. To perform these functions, must we have control weapons that reside in the environment or can they be terrestrially based? What type of weapons should be deployed? How should they be deployed?

Laser Weapons. One of the proposed antispacecraft systems is a ground-based laser, either fixed or mobile. A ground-based laser weapon has several advantages over a space-based one in that it would not be constrained by space logistics and would not have the positional sovereignty "vulnerability" of space vehicles. On the other hand, it would have the disadvantage of generating the laser beam within the atmosphere (more difficult than doing so in the vacuum of space) and trying to shoot through the atmosphere. (One proposed basing scheme positions the laser on mountain tops to overcome some of the atmospheric attenuation problems.)(38) Atmospheric attenuation would limit the ground-based laser's ability to shoot through much of the atmosphere; therefore, it may be able to attack only those targets that are overhead or nearly overhead. In addition, the absorption of the beam by rain, clouds, and haze would make the ground-based laser a fair weather weapon. These operational constraints along with the normal territorial siting limitations would probably allow the laser to deny low-altitude overflight and possibly protect satellites while they were over home territory in good weather but would not permit it to be a space control weapon.

A variation on the ground-based laser theme is a ground-based laser with a mirror in space that is used to redirect the beam to the target. Because atmospheric attenuation and beam spreading still

affect the beam as it passes from the ground-based laser to the mirror, the mirror will not be at a very high altitude; in fact, it may be near enough to the airspace boundary to be vulnerable. In this scheme, the space mirror is defenseless when not within line of sight of the ground-based laser and is especially vulnerable as its orbit takes it over enemy territory. Finally, the laser-mirror system will not eliminate all of the geographical and altitude constraints of the ground-based antispacecraft laser.(39)

The terrestrially based antispacecraft laser weapon could also be deployed in an aircraft. In this configuration, the laser would be above major atmospheric effects, independent of space logistics, and, due to its mobility, able to intercept spacecraft over airspace controlled by friendly forces; but it would still be geographically limited in coverage. Furthermore, for employment of the airborne laser at the long ranges required for high-altitude targets, the aircraft might be too unstable a platform (compared to a ground station or a spacecraft, which receives no atmospheric buffeting) to provide the necessary pointing accuracy.(40) Although the laser in an aircraft may be the most versatile of the terrestrial-based options, it seems to suffer from the same general limitations--area and altitude coverage. It would seem that attempting to control space using terrestrial-based antispacecraft weapons is just as difficult as attempting to control the air with only ground-based antiaircraft weapons or the sea with shore batteries. Thus, logic dictates that a space control weapon must be stationed in space.

The Space Cruiser. The space-based space control weapon system, hereafter termed the space cruiser, will be different from today's satellites. It will not be constrained to occupy given orbits in order to provide earth coverage, as are most current satellites. Space cruisers could protect individual satellites by providing one-on-one escorts; however, this is a dubious tactic considering the number of individual satellites deployed, the logistics handicap in getting to the environment, and the principle of war known as mass. This tactic would be particularly questionable in light of the findings of the previous chapter, which indicated that space forces, like air and sea forces, will control their environment by destroying enemy forces, not by occupying territory. Space cruisers could occupy points in the cluster zones and defend the satellite, located there in the same manner that fixed shore batteries defend harbors. But unlike surface terrain features that provide a defensive advantage to ground forces, the space “terrain features” that cause cluster points provide no defensive advantage to space forces; therefore, using space forces as “fixed” defensive assets does not appear to be a good tactic. In sum, the space cruiser should be neither a quasi-positional nor a fixed asset but a maneuvering warship like its seagoing namesake.

This does not mean that the space cruiser will be a space fighter like those of popular film fame that are based on an air fighter model. Because of the logistical problems in supplying fuel to the environment the space cruiser will spend most of its time either in fixed orbit like its quasi-positional satellite brother or making slow orbital changes using a low-thrust propulsion system. Flank speed using high-thrust engines for short times will be reserved only for wartime or crisis situations. The ability to outmaneuver the enemy will be largely dependent on a nation's technological advantages in propulsion systems and space logistical systems.

How will the space cruiser be armed? Based on current technology, the candidate weapons seem to be either laser or projectile weapons, each of which has advantages and limitations. The idea

of a space weapon that travels at the speed of light over the long ranges which characterize the space environment makes the laser an attractive option. Even though many experts have grave doubts about laser technology in the BMD role, even some of the most pessimistic admit that lasers could be developed as an antispacecraft weapon.(41) But there are serious technological hurdles to be overcome. The recent successful test of the airborne laser laboratory indicates at the very least that lasers can be constructed to a size that makes space-basing possible even though it may require more than one shuttle load.(42) Nevertheless, it may be extremely difficult to construct a device that not only can operate in space but can do so for a long period of time without human attendance. Laser pointing and tracking will present more difficult technological problems than the guidance of projectile weapons because there can be no mid- or final-course correction with a laser beam. Finally, the command and control arrangements required for battles whose tempo is dictated by weapons that travel at the speed of light are mind boggling. In sum, the laser weapon appears feasible in principle but may be many years away in practice. Because of its potential as a space control weapon, however, the development of the laser weapon should be vigorously pursued.

Nevertheless, the first practical weapons to be deployed on the space cruiser probably will be projectile weapons. Based on our broad terrestrial experience with missile systems, the technology for building terrestrial-based projectile weapon system is mature. However, building these systems to survive long inactive periods in the space environment may be another matter. We may also find it unexpectedly difficult to develop guidance technology that will allow the missile to acquire the target based on information provided by the surveillance system. It is long past time to start solving these problems.

Organizational Structure

A frequent argument is that these technological problems have not been addressed because of the lack of the proper organizational arrangements to deal with space forces. Some elements of organizational doctrine are suggested in the preceding chapters about environmental doctrine. As mentioned in chapter 3, there are two organizational issues--the operational organization that employs forces in combat and the bureaucratic organization that sees “combat” in the arenas where the budget dollar is divided.

The previous chapter argued that the operational organization should be built on the Air Force concept of centralized control, but the application of that concept with space forces will be somewhat different. Until we develop space control forces, space forces will be primarily support forces that either collect, transmit, or relay data. In peacetime, we can determine the using organizations and their priorities for both wartime and peacetime operations. Issues of space resource use need not be settled by the operational commander. Those issues include such questions as who has priority use of the channels of a communication satellite and if a weather satellite should be moved to cover another part of the earth. The operational commander of space forces will not have the apportionment problems that a commander of air forces encounters.

The space force commander will have the problem of orchestrating the space battle. If individual assets are threatened, the commander will take defensive measures--either passive (maneuvering, decoy deployment, etc.) or active ones--after space control weapons are deployed. Some of these

defensive measures must be based on prior coordination (probably preplanned in peacetime) with the spacecraft's user. For example, the space force commander might deploy decoys and take some electronic countermeasures without prior coordination. Defensive measures such as maneuvers, shield deployments, and emission control, which affect the spacecraft's support to the users, would have to be preplanned or coordinated with the users before the attack. To accomplish this whole range of defensive countermeasures, the space commander will need operational control of the spacecraft.

Operational control could be transferred to the space commander on warning of hostilities or could be both a peacetime and wartime function of the space commander. The latter makes more sense from the standpoint of efficiency, as it would require no duplication of effort. In addition, because most space forces will be unmanned, we will not be able to rely on the judgment of the individual on the scene to sustain operations until organizational switches are made. To use an analogy, the space commander will be much like the commander in chief, Military Airlift Command. Most of the command's assets support other organizations and services but are under the commander's operational control.

The greatest debate about organizational doctrine for space forces has concerned the bureaucratic organization of space forces, and for good reasons. Before the establishment of a Space Command in 1982, space forces were assigned to various military organizations according to mission.(43) Since the shortfalls in this arrangement could be the subject for a separate book we will mention only a few that will continue to have some impact into the future. First, there was no organization that could arrange a marriage between space systems and the valid military requirements that they could satisfy. Second, there was no organization to act as the advocate for space systems that could provide support across broad functional elements (e.g., global navigation systems). Third, because of the lack of a cognizant organization and the compartmented security arrangements, there was no way to determine if currently deployed space systems could satisfy new operational requirements. The most serious shortfall was that there was no career progression pattern for the individual assigned to these separate operational fiefdoms. In other words, there was no systematic effort to develop the talent required to lead either the operational or bureaucratic space organizations of the future.(44)

Those who argue that a space force should be formed today overlook the enormous task facing Space Command. Many years will be required to overcome the organizational neglect of the last 25 years brought on by the sanctuary doctrine's antimilitary organizational tenets. Furthermore, the lack of experienced personnel capable of making the term *spaceman* as legitimate as the terms *airman* or *seaman* could gravely hinder Space Command's efforts to make up for those 25 years of neglect.(45) Those who believe, as I do, that a space force will be required in the future must remember that Space Command will require many years to grow into a United States Space Force.

Summary

The prescription for the space power doctrine presented in this chapter is not radically different from the path the United States has already taken. It calls for a complete space transportation system to augment the space shuttle, a system which includes space stations and a family of

high- and low-thrust upper stages that will help maintain this nation's technological control of the environment. While this space transportation system will support both civilian and military users, we should develop a separate and primarily military vehicle, the aerospace plane, as soon as possible. One function of this logistical system will be to allow military personnel to travel to and be supported in space. The employment of military personnel in the environment should be a priority effort because sooner or later they will be needed to cope with the fog and friction of war. Partly because man will not be ubiquitous in space for many years, a space-based space reconnaissance and surveillance system is needed immediately to be the eyes and ears of the ground-based space commander. The space commander not only will command those space control weapons that should be developed and deployed soon but also will have operational control of all spacecraft. As to organizational arrangements, one day the term *spaceman* will mean a military member of the United States Space Force, not a creature from some other planet.

NOTES

1. Alfred Thayer Mahan, *The Influence of Sea Power upon History, 1660-1793* (New York: Hill and Wang, 1963), 25.
2. Mahan was impressed with the ubiquity of the English soldier, which he saw as a measure of British sea power. He even invented the word "manywhere" to describe their presence: "It is not that there is so many of him, but that he is so manywhere: in our single voyages, at places so far apart as Cape Town, Aden, Bombay, Singapore, Hong Kong." William E. Livezey, *Mahan on Sea Power* (Norman: University of Oklahoma Press, 1947), 7.
3. Australia, France, Italy, Japan, China, the United States, the Soviet Union, the United Kingdom, and India currently have or did have launch capabilities. National Aeronautics and Space Administration, *Aeronautics and Space Report of the President, 1981 Activities* (Washington, D.C.: US Government Printing Office, 1982), 73.
4. India expects to have the capability to reach sun-synchronous orbit (900 km) by 1987, and expects to have a geostationary capability by 1990. Jerrold F. Elkin and Brian Fredericks, "Military Implications of India's Space Program," *Air University Review*, May-June 1983, 56-63.
5. "NASA's Shuttle pricing policy is designed to recover all operation costs….As a matter of policy, research and development costs will not be recovered. The pricing structure…is intended to encourage full use of the system." House, Committee on Science and Technology, Subcommittee on Space Science and Applications*, United States Civilian Space Programs, 1958-1978*, 97th Cong., 1st sess., 1981, 599.
6. Between 1957 and 1981, the United States attempted 1,205 launches of which 149 were failures, a success rate of 87.6 percent. While one might expect that the success rate has greatly improved over the last several years, the success rate was only 93 percent between 1977 and 1981. NASA, *Aeronautics and Space Report of the President*, 73.
7. These arguments are summarized in Don A. Hart, "Why Use a Truck?" (Paper presented at the Fifth Air University Air Power Symposium, 23-25 February 1981), 2.
8. The Delta launch vehicle can carry a payload of 3,900 pounds and weighs 261,000 pounds at liftoff--a payload-to-vehicle weight ratio of .0149. The Titan IIIC carries a payload of 28,500 at a launch weight of 1,400,000 pounds--a ratio of .0203. The shuttle can carry 65,000 payload (design goal) with a liftoff weight of 4,420,000 pounds--a ratio of .0147. Air Command and Staff College, Space Handbook, ed. Charles H. MacGregor and Lee H. Livingston (Maxwell AFB, Ala.: Air University, August 1977), 6-1 to 6- 11.
9. Bernard R. Bornhorst, "Propulsion for Advanced Space Launch Vehicles" (Paper presented at the Fifth Air University Air Power Symposium, 23-24 February 1981), 6-11.
10. Ibid., 10. Bornhorst has examined the problem of on-demand launch with bulk carriers. He estimates that for a liquid oxygen/ hydrogen propellant system the power required only to top off the tanks as propellant boils off would require 25 megawatts of energy.
11. "The Space Tug was to be the ultimate upper stage." It was to be capable of delivering 8,000 pounds to geostationary orbit, returning to low-earth orbit with a 4,000-pound payload. In fiscal year 1973, Congress funded the shuttle but not the tug. Because more than 50 percent (60 percent today) of Air Force missions were to require an upper stage, the Air Force decided to fund an interim, less-capable stage to suffice until the tug was built. NASA continued to carry the tug on the books as a future capability but had no money to build it, and thus the "interim"

became “inertial” in 1978. Maj Sanford D. Mangold, USAF*, The Space Shuttle, A Historical View from the Air Force Perspective*, Air Command and Staff College Research Report Number 83-1540, April 1983, 28-29.
12. “Inertial Upper Stage Prepared for Extensive Prelaunch Tests,” *Aviation Week and Space Technology*, 3 August 1981, 21-27.
13. Robert Salkeld and Donald W. Patterson, “Space Transportation--New Headings for the Future*,” Astronautics and Aeronautics*, April 1978, 28-34.
14. For details of the cost comparisons between high- and low-thrust upper stages from the total space transportation system point of view, see the following articles: John J. Rehder and Kathryn E. Wurster, “Electric vs Chemical Propulsion for a Large-Cargo Orbit Transfer Vehicle,” *Journal of Spacecraft and Rockets*, May-June 1979, 129-34; John J. Rehder et al., “Propulsion Options for Space-Based Orbital Transfer Vehicles,” *Journal of Spacecraft and Rockets*, September-October 1979, 333-37.
15. For example, in a study done at the Air Force Rocket Propulsion Laboratory in which future Air Force upper stage requirements were examined, the total requirement was divided into five categories. Low-thrust electric propulsion was eliminated from consideration in three of the five categories because of the long orbital transfer time. Melvin V. Rogers, “Propulsion for Spacecraft Deployment” (Paper presented at the Fifth Air University Air Power Symposium, 23-25 February 1981), 6-12.
16. Salkeld and Patterson, 31.
17. The Manned Orbiting Laboratory was canceled in 1969 while the Space Task Group was still preparing its space transportation system recommendations for President Nixon. One Skylab vehicle was placed in orbit in 1973, but the second was canceled in the fiscal year 1971 appropriation. Sanford D. Mangold, 4-15.
18. Recognizing that the space shuttle would not always fly fully loaded, NASA instituted the “getaway special” program in 1976. For $3,000 to $10,000, anyone with a legitimate research experiment could reserve space for a five-cubic-foot canister. A description of the first getaway specials flown on the third *Columbia* test flight is contained in David Yoel et al., 'The First Getaway Special--How It Was Done,” *Space World*, May 1983, 9-16.
19. For an imaginative view of the possibilities in space over the next two decades, see Ivan Bekey and John E. Naugle, “Just over the Horizon in Space,” *Astronautics and Aeronautics*, May 1980, 64-76.
20. Maj Gen John Storrie, director of space operations and plans, does not think that the Air Force needs a space station. He recently stated, “At the present time there is no requirement for the Air Force to put a man in a space station.” “No Air Force Space Station,” *Space World*, June-July 1983, 11. Under Secretary of Defense Richard DeLauer contends, “We have not identified any use [for a manned space station] not better served by unmanned spacecraft.” On 25 January 1984, President Reagan directed NASA “to develop a permanently manned space station and to do it within the decade.” “Away Space Station,” *Aerospace America*, March 1984, 12-13.
21. For example, at the battle of the Falkland Islands in 1914, one of the German objectives was to seize the British coal stored there. E. B. Potter and Adm Chester W. Nimitz, *Sea Power* (Englewood Cliffs, NJ.: Prentice-Hall, Inc., 1963), 405.
22. Mahan, 72.
23. William H. Goesch, “Space Logistics: A New Look at an Old Concept” (An unpublished paper prepared for an Air War College Space Doctrine elective, November 1981), 1.
24. Ibid., 2.
25. Ibid., 2-8.
26. The aerospace plane could maneuver by dipping down into the atmosphere and maneuvering like an airplane, then boosting itself back into orbit.
27. The Manned Orbiting Laboratory “Was to be directed specifically to determining man's utility in performing military functions in space,” Robert Frank Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force, 1907-1964* (Maxwell AFB, Ala.: Air University, 1974), 436.
28. In 1963, Secretary of Defense Robert S. McNamara questioned the need to develop reentry techniques with Dyna-Soar when the broader question, “Do we need to operate (manned vehicles) in near-earth orbit?” had not been answered. He subsequently canceled the program. Futrell, 436.
29. Both Secretary of the Air Force Harold Brown and Secretary McNamara had doubts as to the value of man in space. In 1963, McNamara stated, “Today it appears to us we can achieve military capabilities in space more quickly without a man than with a man.” Quoted in Futrell, 435. The military capabilities McNamara had in mind were probably surveillance activities. Klass reports that the first successful satellite surveillance mission was Discoverer 14, launched in August 1960. By 1963, such missions were routine. Philip J. Klass, *Secret Sentries in Space* (New York: Random House, 1971), 80-108.

30. Air Force Deputy Assistant Secretary for Space Plans and Policy Charles Cook recently said, “Having developed unmanned systems that work so well, coupled with our limited manned space flight experience, we still have many questions pertaining to the military man's role in space.” Charles Doe, “Soviets Test Manned Space Plane,” *Air Force Times*, 15 August 1983, 23-24.
31. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ.: Princeton University Press, 1976), 119.
32. Ibid., 120.
33. Ibid.
34. G. Harry Stine, *Confrontation in Space* (Englewood Cliffs, NJ.: Prentice-Hall, Inc., 1981), 127.
35. Lt Gen Jerome F. O'Malley, “The Air Force in the Space Era,” *Supplement to the Air Force Policy Letter for Commanders*, January 1981, 5.
36. For an overview of the limitations of the current US space surveillance system, see “Space Surveillance Deemed Inadequate,” *Aviation Week and Space Technology*, 16 June 1980, 249-59. Details of the limitations of ground-based sensors are contained in Donald Kessler et al., “Collision Avoidance in Space,” *IEEE Spectrum*, June 1980, 37-41.
37. Ibid., 37. Kessler estimates that in 1980 there were 10,000 to 15,000 objects in space, of which about 4,600 could be detected and tracked.
38. For an explanation of the atmospheric attenuation problems, see Kosta Tsipis, “Laser Weapons,” *Scientific American*, December 1981, 51-57.
39. Wallace D. Henderson, “Space-Based Lasers: Ultimate ABM System?” *Astronautics and Aeronautics*, May 1982, 44-53.
40. Edgar Ulsamer reports that unanticipated jitter was the reason the Airborne Laser Laboratory failed to shoot down its first two targets, even though they were at very close ranges. Edgar Ulsamer, “The Long Leap toward Space Laser Weapons,” *Air Force Magazine*, August 1981, 58-64.
41. Tsipis, 56. Kosta Tsipis, one of the most pessimistic scientists writing on the application of lasers as weapons, grudgingly admits that they might be feasible as satellite killers. However, he dismisses the possibility by arguing that satellites are so vulnerable to projectile weapons that there is no need to develop lasers.
42. Ibid., 58. The Airborne Laser Laboratory was scheduled to destroy its first targets in 1974. The first successful kill was apparently in July 1983. “Flying Laser Lab Knocks Out 5 Missiles in Test,” *Air Force Times*, 8 August 1983, 24.
43. The organizational shortfalls are described by Dr Charles W. Cook, deputy assistant secretary of the Air Force for space plans and policy, in Charles W. Cook, “Organization for the Space Force of the Future,” a paper presented at the US Air Force Academy Military Space Doctrine Symposium, 1-3 April 1981, and published in Military Space Doctrine: The Great Frontier, 4 vols., comp. Peter A. Swan (Colorado Springs, Colo.: USAFA, June 1981), 467-99.
44. Lt Col Robert B. Giffen, USAF, “Spacepower: Space Systems Distribution and Training Management,” a paper presented at the USAFA Military Space Doctrine Symposium, 1-3 April 1981, and published in *Military Space Doctrine: The Great Frontier*, 2:332-45.
45. According to the vice commander in chief, North American Aerospace Defense Command, Maj Gen Robert A. Rosenberg, “In the future, our biggest limiting factor could be the lack of skilled personnel in the space career field.” Frank Ruybalid, “Education Cited as Critical to Space Program,” *Colorado Springs Sun*, 10 September 1983, 17.